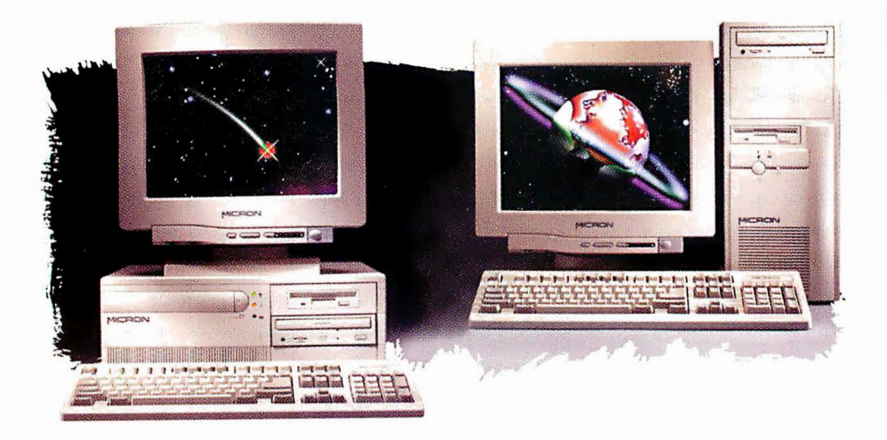

SPECIAL ISSUE
BYTE
SEPTEMBER 1995
Revealed! When the P6 Is Slower than the Pentium P. 24
Telephony's Killer App P. 215
CompuServe, AOL, Prodigy: Which Wins Web War? P. 229
THE MAGAZINE OF TECHNOLOGY INTEGRATION
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May 30, 1995
P120 MILLENNIA



June 28, 1994
P90PCI
POWERSTATION



May 16, 1995
P90 HOME MPC



July 1995
P90 HOME MPC



February 1995
P90 HOME MPC



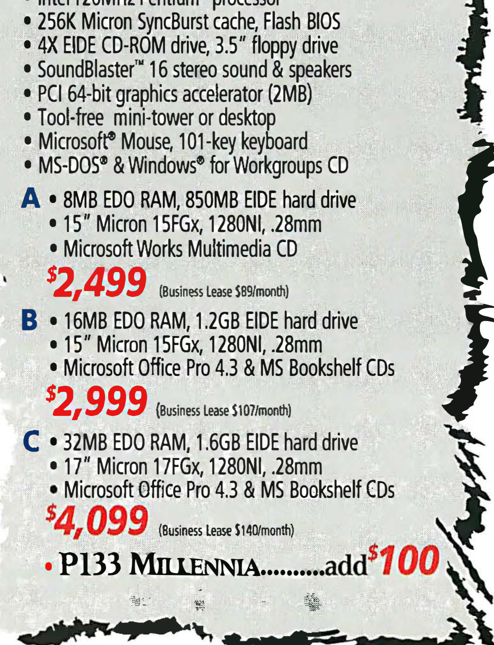
October 1994
P90PCI
POWERSTATION

intel inside
pentium PROCESSOR

THE MICRON MILLENNIA

"Buyers looking for the fastest system money can buy will find it in the Micron Millennia."
PC Week, May, 1995

And the reason for the Micron P120 Millennia's amazing ability to far outperform the competition? It's exclusive dynamic combination of Micron's EDO (Extended Data Out) Memory and SyncBurst™ cache, providing significant performance gains over previous memory designs. Once again, another major breakthrough in computing performance innovation from Micron, the technology leader.



"The Millennia is nothing short of the best all-around PC available on the Market today."
PC Magazine, April 25, 1995



May 30, 1995
P120 MILLENNIA

According to PC Magazine's most recent Windows based tests, the Micron P120 Millennia is a "star performer." The Millennia garnered the highest Graphics WinMark score ever seen, in addition to a top-notch Winstone score.



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SEPTEMBER 1995 VOL. 20, NO. 9

SPECIAL ISSUE

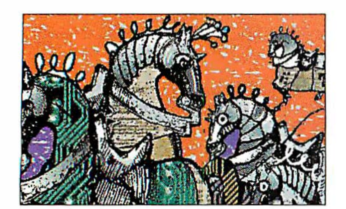
Features

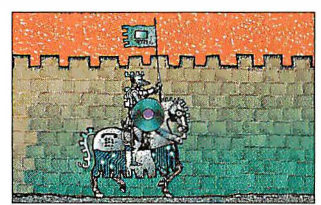


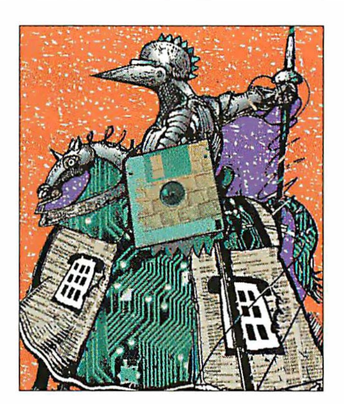


THE BYTE NETWORK PROJECT

State of the Art







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Opinions

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BYTE Contents by Platform

This page presents the articles in this issue according to computing platform.

DOS/WINDOWS

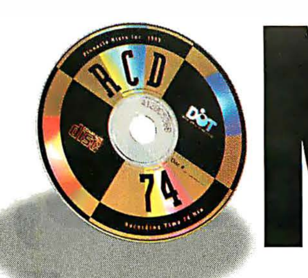
OS/2

MACINTOSH

UNIX

NETWORKS

Index

BACKUP  N CD!

2 out of 3 Recordable CD Systems sold today are Pinnacles!

THE #1 SELLING RECORDABLE CD SYSTEM BY PINNACLE MICRO $1295*

THE PINNACLE RCD-1000 IS 3 DRIVES IN 1!

1. 2X Recordable CD System

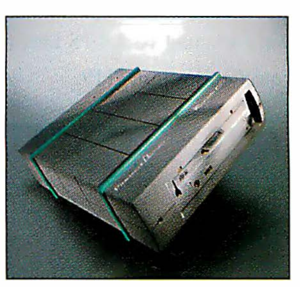
2. Double-speed CD-ROM Player

3. Tape Backup Replacement

The RCD-1000™ is virtually 3 drives in 1 - making it the ultimate storage device for only $1295. With the flexibility of Pinnacle's RCD-1000, the applications are endless. It's even plug-and-play compatible with Windows 95! As a **CD Recorder**, the RCD-1000 allows you to master your own CD that can be easily transported across town - or across the globe. As a **double-speed CD-ROM player**, it can read virtually thousands of educational, multimedia or audio CDs. And with Pinnacle's new **Backup Utility**, you can now replace your tape drive with a system that provides a more reliable solution and fast random access to your data for only $19 per disc, or **3 cents** per megabyte. Each disc boasts 650 MB of data, audio, and video storage capacity.



RCD-1000™ *internal with SCSI controller & software*
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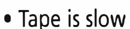


RCD-1000™ *external with SCSI controller & software*
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Includes: Recordable CD software, valued at over $500, as well as the new UP! Multimedia CD with 100 Startup Motivational Videos, a $59.95 value, *and* 2 pieces of FREE Recordable CD media!

TAPE IS OUT.





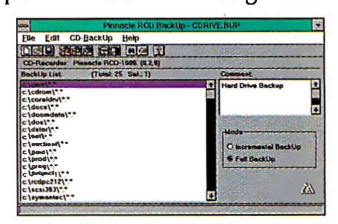
- Tape is slow
- No random access
- Five-year shelf life (Avg.)
- Too many different formats
- Reliable?

OPTICAL IS IN.



- Recordable CD is fast
- Random access
- One hundred-year shelf life
- CD-ROM standard format
- Very reliable

The RCD-1000 is perfect for creating and mastering your own multimedia titles, interactive games, or even mixing your own audio CD of favorite tunes. You can back up accounting records, business plans, charts and graphs, or confidential information on CDs for decades - safe and secure. The RCD-1000 system is simply **the best** way to store, archive, distribute and create information. Best of all, it's now affordable - it's recordable!



RCD Backup Utility

*PC internal version



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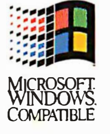


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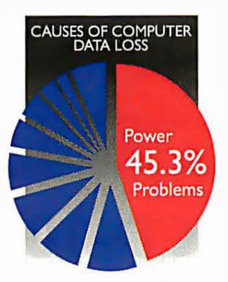
Circle 81 on Inquiry Card (RESELLERS: 82).

New Back-UPS®: $119 blackouts, brownouts

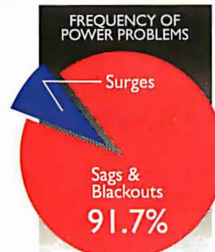


Just don't have the time for power problems on your PC? Don't worry. They'll always make the time for you. It's not if a power problem will occur, but when. Due to household appliances, poor wiring, bad weather or even other office equipment, power problems are as inevitable as death and taxes. You can't run, but you can hide, behind APC protection.

That's why we've just introduced new models in our award-winning Back-UPS line, now delivering reliable protection for just $119.



Source: Contingency Planning



Source: Bell Laboratories

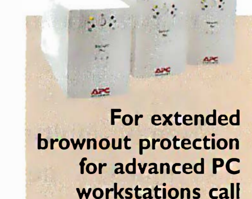
In the next three months, more than 30,000,000 PCs will be hit by power problems...

Who needs power protection? If you use a computer, you do. A study in a recent *PCWeek* showed that the largest single cause of data loss is bad power, accounting for almost as much data loss as all other causes combined. Every PC plugged into an outlet is vulnerable. In fact, you have better odds of winning the lottery than of escaping the sting of power problems. One study found a typical PC is hit over 100 times a month, causing keyboard lockups, hard drive damage, and worse.

Simply put, if power problems are the least of your troubles, you've got one chance to keep it that way. You insure your car and home with the best policy you can afford. It just doesn't make sense to leave your PC (which is at far greater statistical risk) vulnerable to loss or damage.

Why a $119 APC UPS costs less than a $9.99 "surge protector"...

Contrary to most people's belief, a PC alone already has more protection built into it than a low-end "surge suppressor," which is usually nothing more than a well-packaged extension cord. In other words, going without any protection is just as good as underspending on one of the most important PC decisions you'll make.



And since sags and blackouts represent more than 90% of power problems likely to hit your computer, even quality, high-performance surge suppressors are literally powerless to protect you from data loss.

That's why you need instantaneous battery backup power from an APC Uninterruptible Power Supply to prevent



"Don't take chances. Get the ultimate protection... from APC." --PCWorld

"★★★★ Back-UPS should be standard on every desktop... effective, affordable, designed to last..." --PC Computing

"A UPS can pay for itself the first time it saves your data." --MacUser



"The clear winner in price performance... it's unbeatable..." --PC Magazine UK

Back-UPS

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Test

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LIFETIME EQUIPMENT PROTECTION

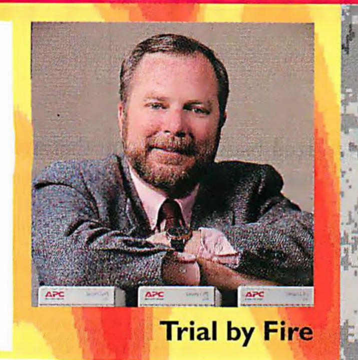
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FOR AS LONG AS YOU OWN THIS PRODUCT, IF YOUR PROPERLY CONNECTED EQUIPMENT IS EVER DAMAGED BY AN AC SURGE, INCLUDING SURGES DUE TO LIGHTNING, APC WILL REPAIR OR REPLACE OUR PRODUCT AND UP TO $25,000 OF CONNECTED EQUIPMENT (SEE POLICY FOR DETAILS, VALID IN U.S. AND CANADA ONLY).

protection against and other trials by fire

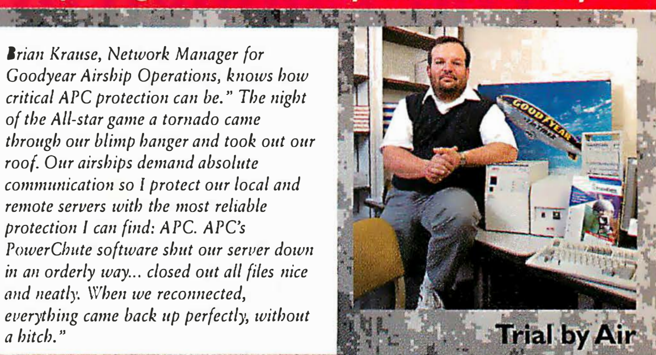
More than 3,000,000 satisfied customers count on APC reliability that goes above and beyond the call of duty

After a raging fire which took 18 trucks to subdue, Michael Benolkin, director of the Systems Division at Correa Enterprises, Inc. didn't expect much. "While rummaging through the ashes, we heard something beeping. Our four APC units were still in action, while two UPSes from another brand were history. We're still using these same APC units at our new office location - they still work like a charm! We're impressed with the ruggedness, reliability, and product support offered by APC."

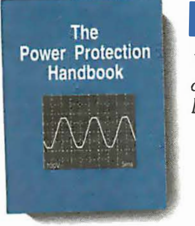


Trial by Fire

Brian Krause, Network Manager for Goodyear Airship Operations, knows how critical APC protection can be." The night of the All-star game a tornado came through our blimp hanger and took out our roof. Our airships demand absolute communication so I protect our local and remote servers with the most reliable protection I can find: APC. APC's PowerChute software shut our server down in an orderly way... closed out all files nice and neatly. When we reconnected, everything came back up perfectly, without a hitch."



Trial by Air



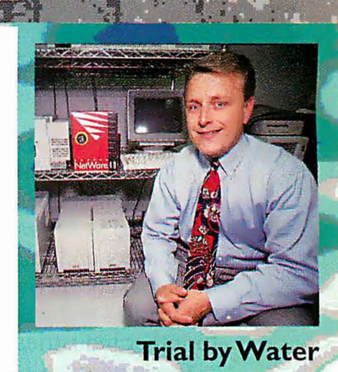
Free 60 - page Power Handbook

What are the myths and musts of PC protection? What are the 10 most common power protection mistakes? The top tips for adding reliability to your LAN? Get your FREE copy and find out!

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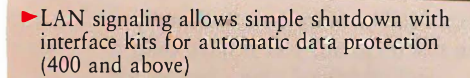
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Brands of UPS used? ______________
servers/PCs to be protected? ______________ **Dept. A2**



Trial by Water



Visit APC's NEW PowerPage on the Internet
www.apcc.com



► LAN signaling allows simple shutdown with interface kits for automatic data protection (400 and above)

► User replaceable, hot swappable batteries insure uptime safe disposal. Batteries will last 3-5 years under normal use.

► $25,000 lifetime Equipment Protection

► 10 minute runtime with specified applications. For longer runtimes choose next largest unit.

Model	Application	Sugg. List
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400	Desktop 486/386 systems	$199
450	Tower 486/386 systems	$254
600	CAD/CAM workstations	$359
900	Longer runtime	$529
1250	Multiple systems	$689

ment, and are available to suit any application, from network servers and PCs, to fax and satellite systems.

PROTECT YOURSELF OR KICK YOURSELF...

It's been said that there are two types of computer users: those who have lost data, and those who are about to. Prevent the single largest cause of computer problems and join a fast-growing third category: those who protect their PC's with the most reliable protection they can buy: APC UPSes. So ask for APC at your favorite reseller. At just $119 an APC UPS is serious protection no serious computer user should be without.

s won more awards for reliability other UPS vendors combined...











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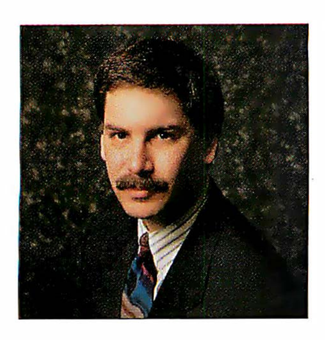
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20 Years 1975-1995

Old Enough to Know Better



You'd think that after 20 years of writing about computers, we'd have learned a thing or two

With this issue, BYTE celebrates its twentieth anniversary. Like most of you, we've been studying the microcomputer business for a long time. I like to think that in 20 years we've learned a lot—not just about computers and the computer market, but about how new markets grow. And most important, how events in the various technology markets can be used as lessons for other industries.

Computers don't cost jobs. If you look at specific markets or companies (say, for example, Smith Corona's typewriter business), you will of course see the elimination of jobs and even entire markets. But the computer industry as a whole is growing rapidly and is a key engine behind job growth in several service industries, such as banking and medicine.

Thanks to advancing technology, many industries are changing more quickly than they ever have. With change comes disruption, competition, and the decline of companies and people who don't track the change. But change also carries opportunity and growth for those who can adapt to it.

Preemptive marketing works. Just ask Adam Osborne, who preannounced his Osborne Model II portable computer while still sitting on a warehouse of Model 1s. Anticipation of the Model II killed what was left of the Model I's sales. In the process, it killed Osborne Computer itself. Of course, giving the market a whiff of vapor can work to your great advantage—witness the hypefest that preceded the Windows 95 launch. Auto manufacturers have been preannouncing products and vague "concept cars" for years. Sure, it's slimy. And it can bite you if you manage it wrong. But that's the way marketing works today.

Technology doesn't always fix problems. Boys will have their toys, but sometimes they have been known to get carried away. Witness Denver International Airport, which is otherwise known as the world's largest bug. The problem: Airline baggage handling is slow, expensive, and error-prone. Denver's solution: A computerized baggage system that avoids the evidence of misrouted luggage by ripping it to shreds. Hint: If the process is fouled up, a computer won't fix it—it will just automate the problems.

The paperless office? Yeah, right. Paper grows on trees—and also in your office. There's a tale that when NASA used to receive satellites from the manufacturer, they came on two trucks: one for the space vehicle and one for the documentation. Now, we have made great strides in indexing and document retrieval in the last 20 years, but people still want their books—and their magazines, thank goodness. Electronic distribution is an additional channel for information, but it cannot replace all other media.

There's always one more bug. There is no such thing as a bug-free computer product. It's the unfortunate nature of the beast. Therefore, if you're going to release a product into the market, you should know ahead of time what you will do if the worst happens. Of course, this applies to all industries, not just technology. Intel didn't realize this until too late, and confidence in its Pentium took a serious dive for a long while. But when Intuit found out about the bug in its TurboTax program, it followed the L.L. Bean model: The company took the product back and fixed it. People still trust Intuit. Be honest with your customers.

Support your customer. Thanks in no small measure to the golden era of free telephone support for computer products (now gone, alas), a whole generation of consumers now expects companies to offer telephone help-desk support. From refrigerators to mutual funds, if a product can possibly confuse somebody, it will. But if confused customers can call you, in their darkest hour of need, and you can rescue them, you'll have built a stronger relationship—and improved your chances for future business.

It's a Webbed world. You say you can't possibly think of another feature to add to your widget? Put Web functionality in it. Everybody else is, after all. Warning: This may not work for the home appliance industry. But then, you never know. ■

RAPHAEL NEEDLEMAN, EDITOR IN CHIEF
(rafe@well.com)

15 Awards and Counting...

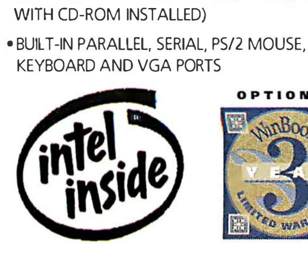
1 PC World — Best Buy - May 1995, WinBook XP SX33 8/260 Monochrome
2 PC World — Best Buy - June 1995, WinBook XP SX33 8/260 Monochrome
3 PC World — Best Buy - July 1995, WinBook XP SX33 8/260 Monochrome
4 PC Magazine — Editors' Choice - August 1994, WinBook XP DX2/50 4/260 Monochrome
5 PC Laptop — Editors' Choice - Most Improved Portable January 1995, WinBook XP
6 PC World — Best Buy - February 1995, WinBook XP DX2/50 8/255 Monochrome
7 PC World — Best Buy - March 1995, WinBook XP DX2/50 8/255 Monochrome
8 PC World — Best Buy - April 1995, WinBook XP DX2/50 8/255 Monochrome
9 PC World — Best Buy - May 1995, WinBook XP DX2/50 8/255 Monochrome
10 PC World — Best Buy - July 1995, WinBook XP DX2/50 8/255 Monochrome
11 Laptop Buyer's Guide — Best Buy - July 1995, WinBook XP DX4/100 8/810 Active Matrix Color
12 PC World — Best Buy - February 1995, WinBook XP DX4/75 8/125 Dual-scan color
13 PC World — Best Buy - March 1995, WinBook XP DX4/75 8/125 Dual-scan color
14 PC World — Best Buy - April 1995, WinBook XP DX4/75 8/125 Dual-scan color
15 BYTE — Best Value 486DX4 Notebook - April 1995, WinBook XP

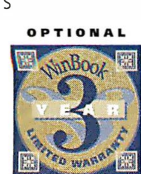
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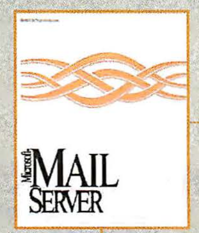
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[1]When available. [2]Operating systems priced separately (Power Series only). Entry-level PC Direct price. Dealer prices and product availability may vary. [3]In Canada, call 1 800 465-3299, enter #'s 45225 and 45226 for Power Series family and 45228 for PC 700. IBM, OS/2 and AIX are registered trademarks and Power Series, PowerPC, Sensory Suite, NetFinity and There is a difference are trademarks of International Business Machines Corporation. All other company and/or product names are trademarks or registered trademarks of their respective companies.

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The BYTE Network Project

I enjoyed Jon Udell's article on establishing a World Wide Web site ("Hello, World," July), especially the sidebar titled "Don't Dis the Host." I, too, use and prefer text-based Internet access. Udell called himself a "knuckle-scraping Neanderthal" for preferring text browsers. Thanks for affirming that there are still some fellow Paleolithic types out on the Internet.

Erik Farquhar
farquhar@acsu.buffalo.edu

Nice to see you guys on the Web. I noticed at the end of your "Hello, World" piece that you mentioned eventually trying out OS/2 and Unix servers. I would find a comparison of Mac vs. other operating systems useful. The freeware MacHTTPd and its commercial incarnation, WebStar from StarNine, are the obvious choices, and Apple offers bundles with all the necessary Internet server software. If you are going to give the other platforms a shot, don't pass over the Mac.

Mark Eaton
marke@nwlink.com

Point taken. I tend not to think of the Mac as a heavy-duty server platform since the OS still lacks robust memory protection and preemptive multitasking. But serving up HTML documents, at least on a modestly trafficked Web site, need not be a particularly demanding server application. Thanks for the reminder.—Jon Udell

I was told that the BYTE Web site would be operational within a couple weeks. Is it ready yet?

Gene Belanger
Houston, TX

Yes, our Web site is up and running, and it provides a link to our FTP server from which you may download BYTE's benchmark source code and executables. Our URL is http://www.byte.com/.—Eds.

MacThanks

I just wanted to thank you for Tom Thompson's expertly written and in-depth article about Apple's upcoming Copland operating system ("Apple's New Operating System," June). Your articles about Macintosh technology have always been excellent, and I look forward to reading them. See if you can sneak some more in.

In a world holding its collective breath for Windows 95 (or 96), it was refreshing to read about the state of the next MacOS.

Christopher Gervais
cgervais@eworld.com

Free the Net

I was much interested in Arun Mehta's Commentary on "freedom" of the Internet ("Radio Free Usenet," July). My daughter is in Croatia, my sister is in Tennessee, and I am in Atlanta, and we all communicate through E-mail transmitted via the Internet. And now I can send messages to Mr. Mehta in India. He was correct that the old U.S.S.R. had to choose between the benefits of PC technology and the risk of losing control over information. The world is racing ahead toward a global system, and yet some people are still in the dark ages.

Shelia Perkins
Atlanta, GA

I agree wholeheartedly with Mr. Mehta's assessment of the Usenet system. I am particularly concerned about the threat posed to Usenet by the ignorant and misguided efforts of some members of the U.S. legislative bodies.

Richie Trenthem
Memphis, TN
trenthem@rhodes.edu

I want to thank Arun Mehta for his Commentary. I share his concerns about the Exon amendment in particular and Net censorship in general.

Dave Parker
dlparker@dlpinc00.com

Eighty-six U.S. Senators voted to approve a legislative measure that could make people liable for statements they make in E-mail messages that would be protected in a conventional letter. Senator Hatch (R-Utah) characterized the proceedings as "a game, to see who can be the most against pornography and obscenity. It's a political exercise." —Arun Mehta

Tsunami Benchmarks

Your news story about the Power Macintosh 9500 ("Apple's Tsunami: PCI Power," July) includes a table of benchmark results. The floating-point results for a Power Mac 8100/100 are just one-third (.375) as fast as the 90-MHz Pentium baseline. If this were really true, I'm sure Intel would not have downplayed the Pentium's floating-point performance.

Steve Willie
sfw@mcs.com

The Power Mac 8100/100 used an older floating-point library that was much less optimized than the library shipping with the Power Mac 9500. An update to System 7.5 provides this new library to existing 601-based Power Macs. —Tom Thompson

Not Building for Windows 95

I read your sidebar about Microsoft's Windows 95 Migration Planning Kit ("How Best to Migrate to Windows 95," July). Any search tool that requires you to already have Excel, Word, and Power Point installed will be "cluttered and counterintuitive." And I think you were too easy on Microsoft when you called their Windows 95 payback spreadsheet "an incomplete business-analysis tool." It's not incomplete, it's totally useless. I'll stick to Windows 3.11 while this first wave of Windows 95 drowns all the early adopters.

George Morgan
Syracuse, NY

Hey, I think you guys down at BYTE are a little biased toward Windows. You praise Windows 95 when it had not even been delivered. Don't talk about how good it is and just totally ignore a real 32-bit operating system like OS/2.

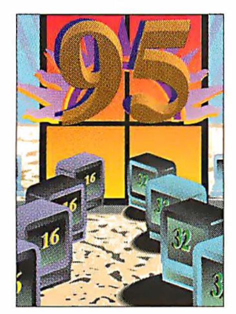
Michael Bernstein
Rockford, IL
insanity@rockford.com

We don't ignore OS/2. See this month's review of Warp Connect ("Networking at Warp Speed," page 235).—Eds.

We want to hear from you. *Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458; or you can send E-mail via the Internet or BIX to editors@bix.com. Letters may be edited.*

The Trouble with Microsoft

Microsoft "could reshape the Internet" ("The Greatest Show on Earth," July)? I hope not. They reshaped the world of operating systems and look what good they did to it. Thanks to Microsoft, we need a 486 to efficiently edit a plain ASCII file, so we can expect to need a direct T1 connection to The Microsoft Network to send E-mail. Fortunately, Microsoft won't reshape the Internet so easily. MSN is not exactly loved by many Internet users, and it won't exactly be welcomed into the Internet community.



The trouble with Microsoft is that speed and bugs don't really affect their products' success. Windows is the best example. The same could happen with MSN.

Petros Raptis
Athens, Greece
prapti@leon.nrcps.ariadne-t.gr

ISDN Lives

I want to compliment you on Sal Salamone's wonderful Core Technologies article "ISDN and Analog Access in One Package" (July). The entry of all of these modem manufacturers into the ISDN market will be good for ISDN. Salamone correctly pointed out that ISDN products are difficult to configure. I believe that these new ISDN product manufacturers will become instrumental in forcing the industry to adopt a simplified "plug and play" approach to ISDN.

Keep up the good work.

Paul D. Cook
Paltine, IL
p.cook@computer.org

I'd Never Be Without You, But . . .

Yours is the one computer magazine I'd never be without. That said, I suggest you reconsider comparative product reviews. Printers, monitors, and VGA cards are mature products, and even if we don't own the best laser printer under $5000 or the best 17-inch monitor, the ones we have are good enough.

On the other hand, the review of telephony products in the May issue ("Small-Scale Telephony") *was* worthwhile because the field is very immature and products often differ significantly or have significant flaws. These are the types of products we need to know about.

Andrew Mayo
andrew@geac.co.nz

Arithmetic 101

In your review of the Tadpole P1000 ("Red-Hot 100-MHz Portable Pentium," June), you claim it is "110 percent to 120 percent faster" than your reference machine. That would make the Tadpole over twice as fast as your 90-MHz baseline. I think you meant "10 percent to 20 percent faster."

John Smythe
Gainesville, FL

Mr. Smythe is absolutely correct; we apologize for the error. —Rex Baldazo

In "Break Up Your Network" (June), the author multiplies bits/second times bits/byte to arrive at a bandwidth in bits/second. I must be missing something here because I end up with a result of bits-squared/byte-second.

Andy Feibus
VP Technology
Process Systems and Integration Inc.
amf@psi2.com

The arithmetic is correct, but the units got scrambled. The error is in the label "Kbps," which is kilobits/second. It should have been "KBps," which is kilobytes/second. With that substitution, the units will cancel correctly.
—Brett Husselbaugh

FIX

We regret the following errors from our June roundup review of SQL tools ("Simple SQL"):

We stated that IQ Software's IQ for Windows does not provide a facility for resolving ambiguous join paths. IQ prevents ambiguous join paths by supporting rule-based table joins. The rules are stored in its repository. In reporting the print speed of IQ for Windows, we timed the speed of a query and print, instead of printing directly from the query screen. IQ's print speed is much faster than represented in the report. And IQ will indeed let you insert criteria from a static list.

Because of incomplete information supplied by IQ Software, the features table on page 220 contained errors. It should go like this:

Add descriptions for column/table names	**Yes**
Define dialog boxes for user queries	**Yes**
Start multiple instances of programs	**Yes**
Permits direct entry of SQL	**Yes**
Replace retrieved values with defined text/values	**Yes**
Generate partial reports	**Yes**
Insert criteria from static list	**Yes**
Add calculated fields without resubmitting query	**Yes**
Report on stored results	**Yes**
Define dialog boxes for user-query entry	**Yes**

IQ Software released version 5 of IQ for Windows soon after we completed our review of version 4.0. Version 5 adds significant enhancements and features. ■

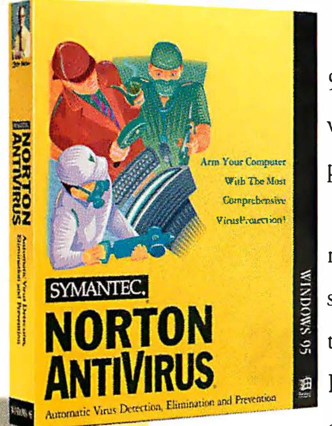
COMING UP IN OCTOBER

- **YOUR NEXT PC**
  Current PCs are built on a 15-year-old architecture. We look at the technologies that are going to bring computer hardware into the 21st century.
- **WINDOWS 95**
  The rubber meets the road as we test Windows 95. Plus, we'll look at some of the upcoming 32-bit applications especially designed for Windows 95.
- **LOTUS WORDPRO REVIEWED**
  Lotus has upgraded Ami Pro, added groupware features, and renamed it WordPro. We test this new addition to SmartSuite.
- **CATCH THE WAVE**
  A close look at the Power Mac 9500, code-named Tsunami, which finally weds PCI and the PowerPC.
- **FAXES ARE SERVED**
  Fax servers are no fun to install, but the payback makes it worth the hassle.

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PREVENTION, PROTECTION WINDOWS 95

So even if you encounter a virus that was just created yesterday by some hacker with a bad frozen pizza habit, Norton AntiVirus will find it and stop it.

And when could you possibly need protection from unknown viruses more than in a brand-new operating system?

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Another thing you may not know is that your old 16-bit utilities won't work in Windows 95.

Work faster and more productively with Norton Navigator for Windows 95.

And the utilities included in Windows 95 itself won't give you much protection in a 32-bit world.

Only native 32-bit utilities can give you adequate system protection in a 32-bit environment.

Which is why you need to upgrade your utilities to Norton Utilities® for Windows 95.

The first thing Norton Utilities will do for you is optimize your system for Windows 95 with a Pre-installation Tune-up.

Then Norton Utilities runs continuously in the background, monitoring your system and automatically launching the right tools to maintain system performance and prevent system crashes.

*Verified in independent tests conducted by NCSA and VSUM, July 1995. **Trade-up editions will run only when specified Symantec, Central Point, McAfee and

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And if something does go wrong, Norton Utilities gives you the data recovery tools users have relied on from day one.

So from the day you install Windows 95, your system is stable and your files are protected.

Norton Utilities keeps your data safe from harm.

THE MORE WORK YOU DO, THE MORE WORK NORTON NAVIGATOR WILL DO FOR YOU.

Windows 95 has lots of terrific features to make life easier. Like Plug 'N Play. And long file names.

You can plug into your Internet connection right from the Norton File Manager. Search for text strings within files at least ten times faster. (In fact, the more files you have and the bigger they are, the more time you'll save.)

And copy a file anywhere on your hard drive or on the network with just one click. Instead of click click click click click click (are you tired of clicking?) click click click click. Which is generally how long it takes to copy a file in Windows 95.

AND PRODUCTIVITY FOR FROM DAY ONE.

But what about getting even more out of Windows 95? Like getting more done in less time.

With Norton Navigator, you can navigate through your desktop five times faster than in Windows 95. Be more productive with multiple project-oriented desktops. Open the files you need most in a single click.

And that's just the first minute.

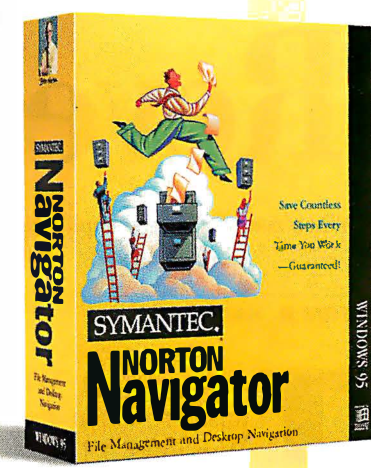
Norton Folder Navigator extends your menu power.

Norton Navigator also lets you use long file names for most 16-bit applications. And gives you loads of other time-saving tools like built-in PK-Zip compatible file compression and the ability to delete, move, zip or encrypt from any Open or Save dialog box.

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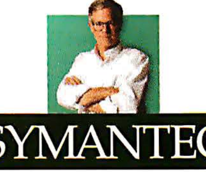
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NEWS & VIEWS

16-BIT SOFTWARE STALLS THE P6

P6 Weakness Revealed

When running legacy applications, a fast Pentium may outperform the first P6 processors

TOM R. HALFHILL

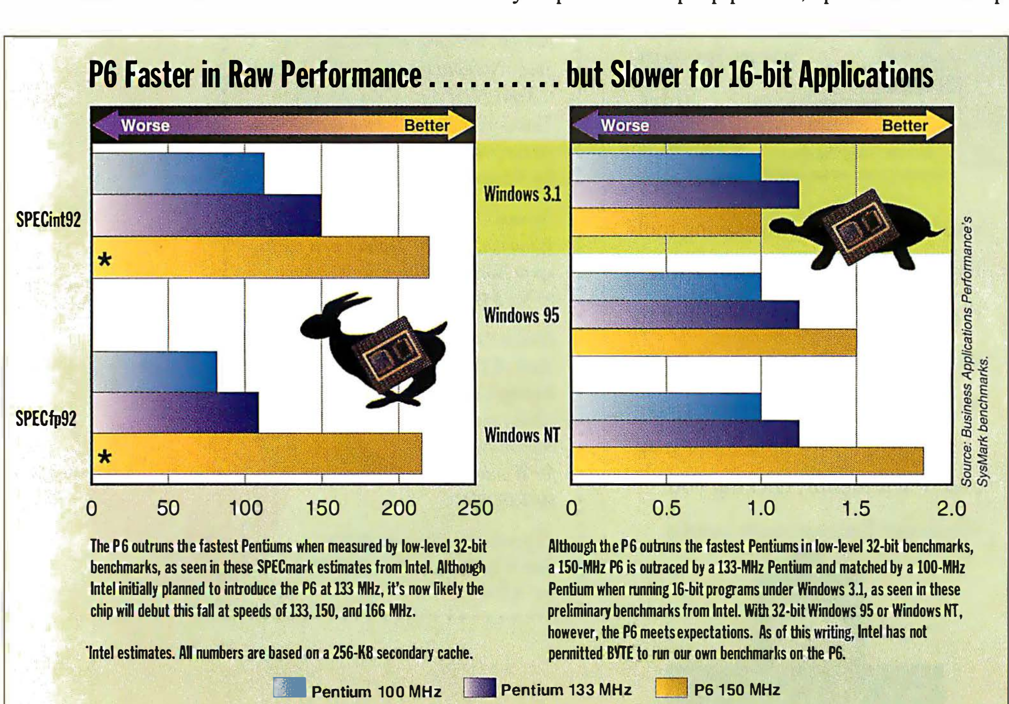
Trick question: When is a Pentium *faster* than a P6? Surprise answer: When it's running 16-bit software, including DOS and Windows 3.1.

Intel's latest benchmark testing reveals that a 133-MHz Pentium consistently outruns a 150-MHz P6 when executing the 16-bit code found in today's most popular software. Even a 100-MHz Pentium runs neck and neck with a 150-MHz P6.

Theoretically, the sixth-generation P6 chip should blow the fifth-generation Pentium out of the water. The P6 has three-way superscalar superpipelines, speculative execution, out-of-order execution, additional registers, 2.2 million more transistors, more headroom for higher clock speeds, a closely coupled secondary cache, and a higher price tag (see "Intel's P6," April BYTE). But some of those fancy features actually *slow down* the P6 when running 16-bit code.

The problem, says Intel, is with today's installed base of software, not with the chip. The P6 is optimized for 32 bits. When Intel engineers began designing the P6 about four years ago, they figured everyone would be running 32-bit software by now. After all, Intel's first 32-bit x86 processor (the 386) dates back to 1985. But the industry hasn't moved quite as fast as Intel and others expected: Most PCs today run 16-bit Windows. When Intel ran the SysMark application-level benchmark programs on a P6, old-generation software embarrassed Intel's next-generation chip.

It's certainly not unusual for a new processor to deliver less-than-optimum performance unless old software is recompiled to take advantage of the new design. That's especially true of RISC processors. While the P6 is still a CISC chip, it adopts several RISC-like techniques. However, it's definitely unusual for a new CPU to run old software *slower* than existing CPUs that share the same



The P6 outruns the fastest Pentiums when measured by low-level 32-bit benchmarks, as seen in these SPECmark estimates from Intel. Although Intel initially planned to introduce the P6 at 133 MHz, it's now likely the chip will debut this fall at speeds of 133, 150, and 166 MHz.

*Intel estimates. All numbers are based on a 256-KB secondary cache.

Although the P6 outruns the fastest Pentiums in low-level 32-bit benchmarks, a 150-MHz P6 is outraced by a 133-MHz Pentium and matched by a 100-MHz Pentium when running 16-bit programs under Windows 3.1, as seen in these preliminary benchmarks from Intel. With 32-bit Windows 95 or Windows NT, however, the P6 meets expectations. As of this writing, Intel has not permitted BYTE to run our own benchmarks on the P6.

Why Legacy

The Pentium currently outperforms the P6 when running 16-bit programs under Windows 3.1 due to a combination of factors. They include the design of the P6 and the hangover of legacy DOS and Windows code.

As described in "Intel's P6" (April BYTE), instructions passed to the P6 are converted into equivalent micro-operations that are loaded into a 40-element circular buffer. Instructions in the buffer pass to the execution unit, which processes between three and five instructions simultaneously, if the data for the specific instruction is available.

If instruction B references a particular register, and instruction A, which precedes B in program flow, also writes to that register, B must wait for A to complete. Therefore, the fewer the dependencies, the faster the

Code Snags the P6

instructions can be delivered to the execution units.

To conserve on the P6's transistor count, Intel decided to shadow (i.e., allow multiple independent instances) the "true" registers as full 32-bit entities only. The result is that any instruction that alters any part of a register will hold up a following instruction that uses any part of the same register, even if the instructions are logically independent. An `ADD AL,6` holds up a `MOV BX,AX`.

If this were a completely 32-bit world (as Intel's engineers had hoped it would be by now), any instruction referencing a register would be held up by, at most, one preceding instruction, and the P6 would "fire on all cylinders." Similarly, if all programs manipulated the CPU registers only 16 bits at a time, the P6 would perform well. Unfortunately, a great deal of code, especially in the DOS and Windows world, manipulates registers as 8-bit entities here, 16-bit entities there, and sometimes 32-bit entities. This "mixing" of data sizes bogs the P6 down, because it has to spend so much time "piecing" the 32-bit registers together from 8- and 16-bit subunits.

Another source of friction for the P6 arises from the ever-dreaded segment registers often manipulated in 16-bit DOS and Windows programs. Again, to skirt what would have been a tremendous multiplication of complexity, the P6 engineers elected not to virtualize the segment registers. So, whereas general CPU registers can be shadowed, only one global instance exists for each segment register. The result is that the arrival of a segment register load instruction "serializes" the CPU: No other instructions can proceed until the load completes.

Furthermore, any instructions that had already been started but appear in the program flow after the segment register load instruction must be dumped and restarted. The "tear it up and start from scratch" tactic is necessary because the source for all instructions and data following the segment load is in question.

Ironically, none of this would be of any significance if the designers of the P6 hadn't made a few excusable miscalculations. In one of the larger mispredicted branches we've ever seen, the P6 engineers in 1990 estimated that most code today would be 32 bits, and that the standard for chip technology, including the Pentium, would be at 0.6 micron running at around 100 MHz. However, hardware again outpaced software. Today's typical PC runs a mixture of 16-bit code on 32-bit OSes. Meanwhile, the latest Pentium is produced on a 0.35-micron process and soon will run at 150 MHz.

The first P6 will not be manufactured on a 0.35-micron process, however. Instead, Intel says it will make the first P6 chips on a more conservative 0.6-micron process. Once it has worked the bugs out at 0.6 microns, Intel says it will move to a more aggressive 0.35-micron process. The company estimates there will be an eight-month period when a similarly clocked Pentium will outpace the P6 in the special circumstances we've described. But once Intel moves to 0.35-micron manufacturing, the P6 will race ahead. **—Rick Grehan**

basic architecture. (For more information on why this is, see the text box "Why Legacy Code Snags the P6.")

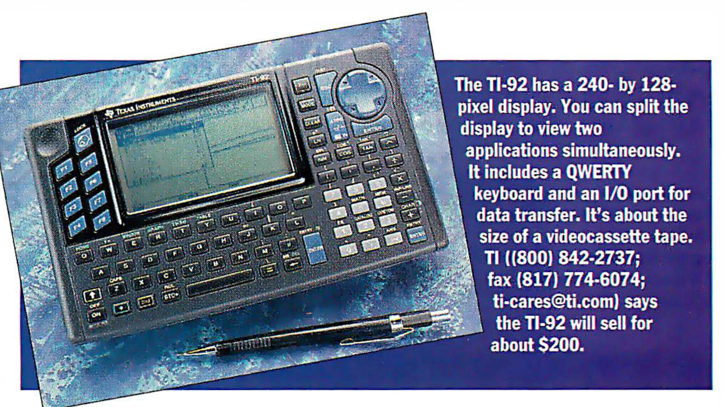
The P6 lives up to expectations with 32-bit code. Intel's benchmarks show that it easily outperforms the fastest Pentiums when running 32-bit applications on a 32-bit OS, such as Windows 95 or Windows NT. Interestingly, however, the P6 does much better with NT than it does with Windows 95. Intel says that there are vestiges of 16-bit code in the Windows GDI (Graphical Device Interface), while NT is thoroughly 32-bit.

The P6's poor showing with 16-bit software is probably not as serious as it seems. High prices will initially limit the P6 to servers and workstation-class desktop systems, whose performance-minded users will almost certainly be running 32-bit OSes and applications. If the P6 follows an adoption curve similar to the Pentium's, it will not appear in mainstream PCs until 1997. By then, 80 percent of new PCs will ship with a 32-bit OS, according to International Data (Framingham, MA). And Windows 95 should accelerate the migration to 32 bits.

Intel says the P6 will get a performance boost when the company moves from its current 0.6- to 0.35-micron process. That raw performance boost should let the P6 outperform the Pentium in running legacy 16-bit software. Until then, anyone who is contemplating the purchase of a P6 should be forewarned: If you're running 16-bit software, the Pentium delivers more bang for fewer bucks.

CALCULATORS

PC Power Comes to the Calculator



The TI-92 has a 240- by 128-pixel display. You can split the display to view two applications simultaneously. It includes a QWERTY keyboard and an I/O port for data transfer. It's about the size of a videocassette tape. TI ((800) 842-2737; fax (817) 774-6074; ti-cares@ti.com) says the TI-92 will sell for about $200.

High-end math capabilities such as symbolic calculus and Euclidean geometry are migrating from PCs to $200 calculators. Texas Instruments (Dallas, TX) says it will release a new calculator called the TI-92 later this year. This calculator delivers interactive geometry, symbolic manipulation, statistics, and even 3-D graphing with an easy-to-use graphical interface.

TI collaborated with the creators of the Cabri Geometry II software at the Université of Joseph Fourier as well as the authors of the Derive algebra that's published by Soft Warehouse in adding the interactive-geometry and symbolic-manipulation features. Thanks to those joint efforts, you can not only determine the integral (that's the area under a curve for those of you who haven't been to calculus class lately) of a curve, you can also get the formula that's used for finding the integral (e.g., the TI-92 will tell you that the formula for determining the integral of x^2+2x+2 is $x^3/3+x^2+2x$).

TI says that the new calculator (see the photo) lets teachers equip a math lab much less expensively. The reaction from BYTE's college interns to the new calculator was universal: "I want one."

—Dave Andrews

WINDOWS 95 DEVELOPMENT TOOLS

Delphi and VB Turn 32

Visual development tools from Borland and Microsoft will soon let you create 32-bit programs that take advantage of the new features and UI (user interface) elements in Windows 95. In mid-September, Microsoft (Redmond, WA) plans to release 32-bit Visual Basic 4.0. Borland International (Scotts Valley, CA) says it will release a 32-bit version of Delphi within 90 days of the commercial availability of Windows 95. These products add stronger support for client/server development and OLE integration. Another 32-bit bonus is Windows NT compatibility. Windows NT 3.5 can be both the host and the target of VB 4.0 and Delphi.

Although the 32-bit code these tools generate will not run on 16-bit Windows 3.1 or Windows for Workgroups, Microsoft and Borland will continue to support their 16-bit versions. Both VB 4.0 and Delphi make the migration to 32-bit Windows development relatively simple. In many cases, you can recompile existing 16-bit code.

Perhaps the biggest obstacle to Windows 95 migration will be the transition to OLE-based custom controls. You can't use 16-bit VBXes (Visual Basic custom controls), which played a major role in VB's success, to build 32-bit software. Instead, you'll use 32-bit OLE controls (formerly called OCXes) that improve on VB's component architecture. Fortunately, many third-party developers have started migrating their VBXes to the OLE model.

Borland's new version of Delphi, when used with Microsoft's Control Development Kit, can create custom controls. However, VB 4.0 cannot do this. This gives Delphi an advantage over VB.

Because VB 4.0 still relies on a run-time interpreter, Delphi will also maintain its performance lead. VB's interpreter is the same Object Basic engine that's found in Microsoft Office's VBA (VB for Applications), but interpreted VB programs generally are not as fast as programs created with Delphi's Object Pascal compiler. In fact, the new version of Delphi will share Borland C++'s 32-bit optimizing compiler.

Although VB cannot build OLE controls, both VB 4.0 and the new version of Delphi will let you create OLE automation objects. These are stand-alone code libraries that expose their routines to other OLE-aware programs.

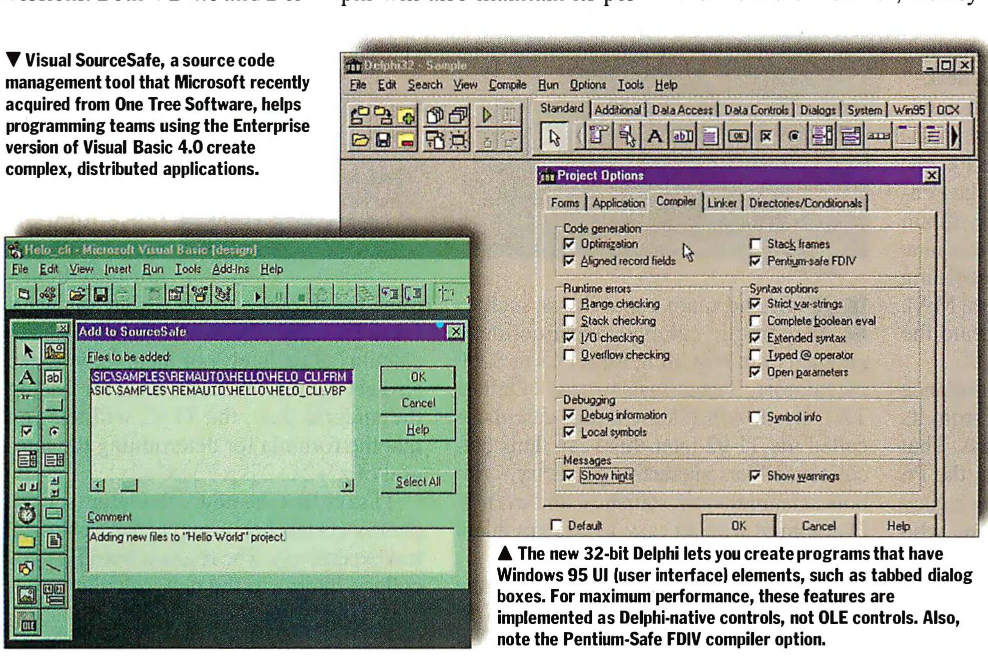
In VB, you create these objects with a new type of module called a class module, containing as few as three lines of code. Public variables in this module become properties, and public subroutines and functions become methods. Other OLE-aware programs can browse these modules, modify their properties, and call their methods. This lets VB create distributed objects for three-tiered client/server systems. You can isolate business rules in OLE objects, separated from both the front-end client application and the back-end enterprise server.

Also new to VB 4.0 is an add-in architecture that's similar to Adobe Photoshop plug-ins. Previously, outside developers had to hack VB to add design-time utilities, such as code formatters and debugging tools. Microsoft now formalizes that architecture by letting OLE-based add-ins appear on a VB menu.

A new IF...THEN statement in VB conditionally compiles blocks of code. If a program calls functions available only in the full Win32 API (e.g., OpenGL graphics), you can tell VB to ignore that code when targeting the Win16 API.

Client/server developers will appreciate the new 32-bit database engines in Delphi and VB. Delphi will have 32-bit asynchronous I/O, new drivers for DB2, deferred updates for transactions on multiple tables, and the ability to execute transactions against local dBase and Paradox files. The new Enterprise Edition of VB 4.0 will include the Jet 3.0 database engine and other client/server features.

Of all the 32-bit improvements, however, perhaps the most important one is the move to 32-bit OLE controls. Unlike VBXes, which are closely tied to the VB architecture, OLE controls will be supported by a number of development tools. This will give visual programmers much more power at their disposal. —TRH



▼ **Visual SourceSafe, a source code management tool that Microsoft recently acquired from One Tree Software, helps programming teams using the Enterprise version of Visual Basic 4.0 create complex, distributed applications.**

▲ **The new 32-bit Delphi lets you create programs that have Windows 95 UI (user interface) elements, such as tabbed dialog boxes. For maximum performance, these features are implemented as Delphi-native controls, not OLE controls. Also, note the Pentium-Safe FDIV compiler option.**

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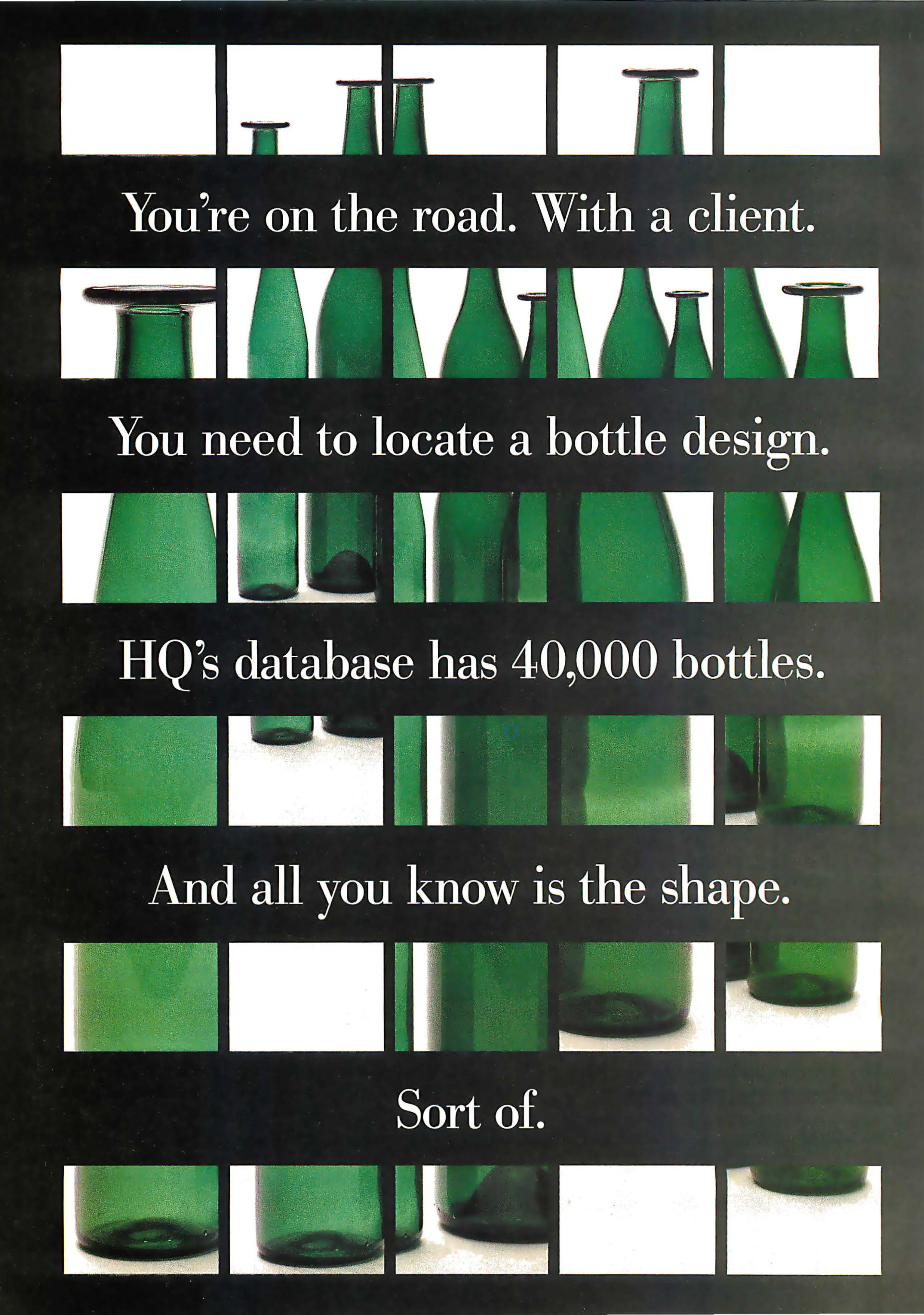
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PC PROCESSOR TRENDS

New 486 Chips Deliver Inexpensive Power

The 486 is reaching the end of its life, but it isn't dead yet. Advanced Micro Devices (Sunnyvale, CA) has developed two chips that shatter 486 speed barriers and offer Pentium-level performance at low-end prices. Meanwhile, Cyrix (Richardson, TX) has developed an unusual CPU that's a cross between a 486 and a 586-class chip.

Although AMD's new processors run internally at 120 and 133 MHz, they use clock-divided buses to remain compatible with existing motherboards. The 120-MHz 486 has a 40-MHz bus and delivers integer performance comparable to a 75-MHz Intel Pentium (see "AMD's 120-MHz 486: Bargain Power"). It began shipping this summer.

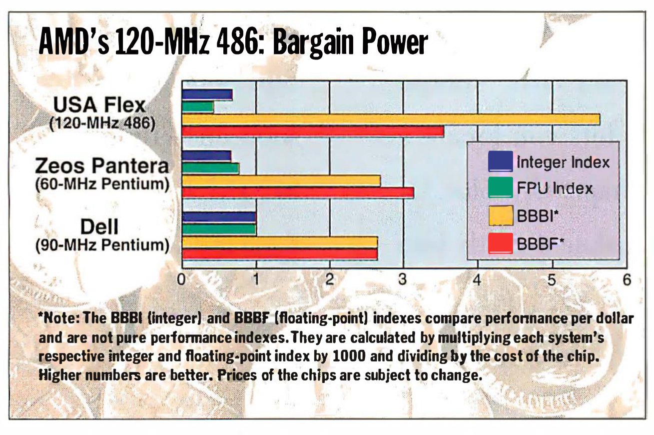
AMD's 133-MHz 486 chip, which is due later this year, has a 33-MHz bus and a 16-KB unified write-back cache, which is twice as large and more efficient than the 8-KB write-through caches found on most 486 chips. However, due to its slower bus and the diminishing returns of pushing an older design to higher clock speeds, the 133-MHz 486 will offer only marginal performance improvement over the 120-MHz chip.

Cyrix is trying to get around the problem of the 486's diminishing returns by introducing a hybrid design called the 5x86 (formerly known as the M1sc). The 5x86 will likely ship in volume by the end of this month.

Depending on your point of view, the 5x86 is either a souped-up 486 or a stripped-down version of the M1, Cyrix's 586-class processor. Gone are the most advanced features that are supposed to make the M1 perform 30 percent to 50 percent faster than a Pentium: superscalar pipelines, speculative execution, extra registers, and a 64-bit data bus. Retained are several features typically found only in fifth-generation microarchitectures: branch prediction, data forwarding, an independent load/store unit, an 80-bit FPU, 64-bit internal data paths, and a 16-KB unified write-back cache.

Internally, Cyrix's 5x86 runs at 100 MHz. Bus speeds can be 25, 33, or 50 MHz. Like a Pentium OverDrive, the 5x86 fits in a 32-bit 486 socket. Future versions will fit into 64-bit Pentium sockets and attain core speeds of as high as 200 MHz.

Why bother with sub-586 designs when Intel is ramping up the Pentium and the sixth-generation P6? One reason: Both AMD and Cyrix are late in delivering their fifth-generation chips (neither the AMD K5 nor the Cyrix M1 will ship in quantity before 1996).



BYTE's native-mode benchmarks indicate that a system from USA Flex ((800) 872-3539) based on AMD's 120-MHz 486 processor achieves integer performance comparable to that of the more expensive 60-MHz Pentium. The system lacks the FPU performance of a Pentium, however. The USA Flex desktop PC with 8 MB of RAM, no monitor, a 545-MB hard drive, a 3½-inch floppy drive, a 256-KB write-back cache, a mouse, and a 1-MB DRAM video accelerator card costs $1049. —DA

Several vendors, including Cybermax, Liuski Systems, USA Flex, and Vobis, say they will use AMD's 120-MHz 486. However, at press time, major system vendors such as Compaq, which already uses AMD processors in some systems, had not committed to using AMD's new 486 chips. One vendor, which requested anonymity, said it would not use the 120-MHz 486 because it thinks Pentium prices will drop dramatically this fall.

Prices to PC manufacturers for these crossover chips range from $120 for AMD's 120-MHz 486 to $147 for the Cyrix 5x86 (in quantities of 1000). That means complete systems can sell for under $1500, which is a key price point in retail channels.

The pumped-up 486 chips should prosper in low-priced desktops and notebooks. For corporate and technical users, however, true 586-class chips look like a better buy. They're a safer long-term investment, and they offer superior performance, especially for floating-point tasks. —TRH

Whatever Happened to . . .

TI's Rio Grande Chip?
(see "TI Charges into the Notebook CPU Wars," April 1994 BYTE, p. 36)

Texas Instruments hoped that manufacturers of subnotebooks would flock to its Rio Grande chip, a 486SX-class processor that integrated a PCI (Peripheral Component Interconnect) bus interface and memory controller with aggressive power management and low power consumption (3.3 V). But two factors helped shelve the chip.

One was that as TI was preparing to release the 486SX-class chip (it had no FPU), the company's notebook partners were shifting to higher-performing 486 processors. Also, it turned out that customers weren't buying a lot of subnotebooks at the time because notebooks that weighed less than 4 pounds had too many compromises.

TI is back in the notebook and consumer markets with an 80-MHz 486-class processor called the TI486DX2, which should enter volume production this month. TI cites the first-quarter 1995 Storeboard Channel Tracking Service, which reported that 57 percent of PCs sold through retail channels in the U.S. were based on 486DX-class processors. —DA



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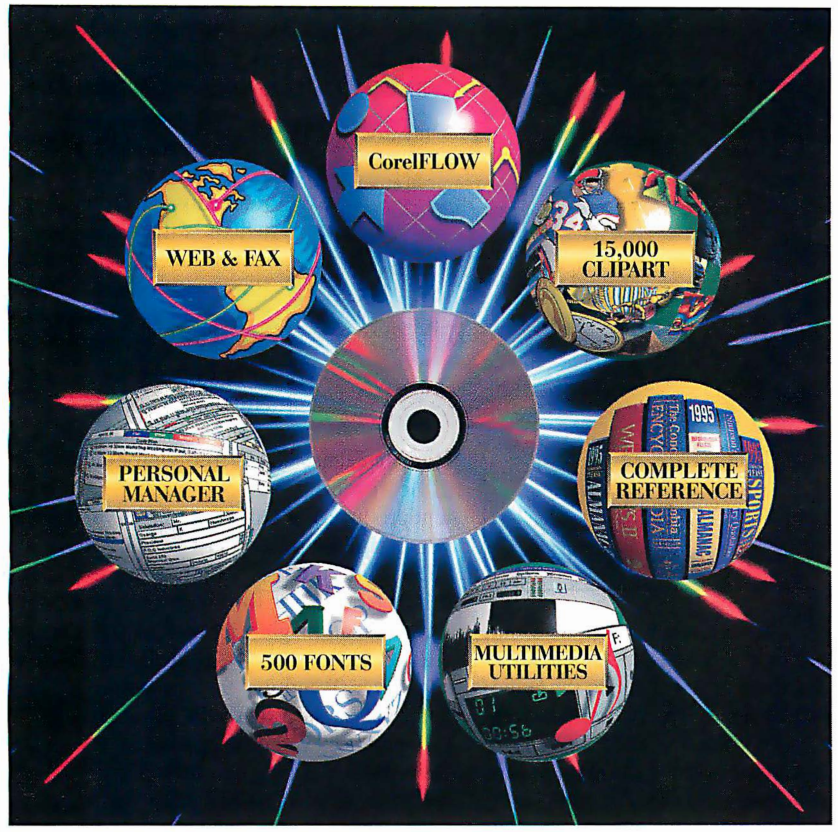
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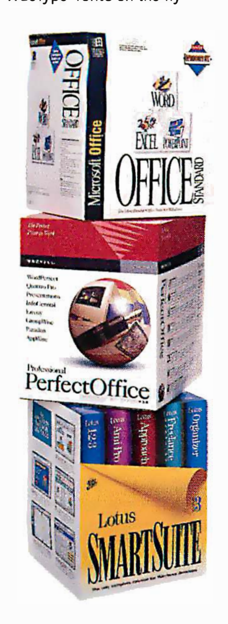
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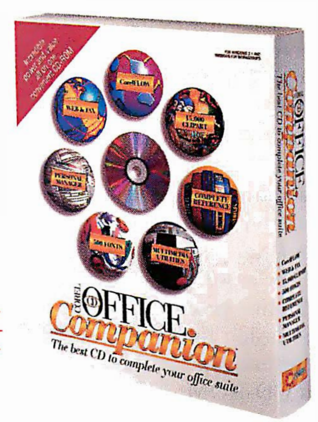
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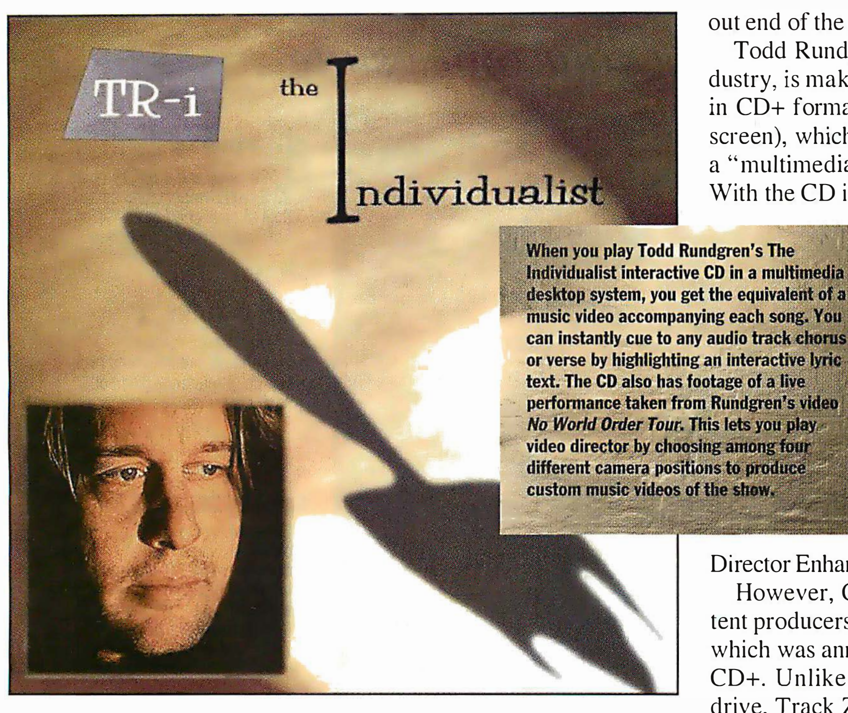


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INTERACTIVE COMPACT DISCS

Interactive Music Videos Arrive for Macs and PCs



When you play Todd Rundgren's The Individualist interactive CD in a multimedia desktop system, you get the equivalent of a music video accompanying each song. You can instantly cue to any audio track chorus or verse by highlighting an interactive lyric text. The CD also has footage of a live performance taken from Rundgren's video *No World Order Tour.* This lets you play video director by choosing among four different camera positions to produce custom music videos of the show.

Imagine listening to glorious digital stereo on your car's CD audio system. But when you arrive home and put the same CD into your computer's CD-ROM drive, you can listen to the audio, plus view interactive music videos, lyric sheets, artist biographies, and interviews. The CD+ (also known as Enhanced Music Compact Disc) format lets you do all the above and brings the audio CD into the era of interactive content delivery using desktop multimedia systems.

CD+ addresses the problem with today's interactive CDs, in which the lyrics, photos, graphics, and video are stored on track 1. When you play track 1 of current interactive CDs on a standard audio CD player, the resulting grating, buzz-saw sound can damage the speakers. The new CD+ format eliminates this problem. CD+ is a two-session format that works on current-generation multisession CD-ROM drives and all standard audio CD players.

CD+ lets content producers put audio tracks of first-session audio as standard CD-DA (Red Book Compact Disc Digital Audio) alongside CD-ROM computer data that was recorded in a second session. An audio CD player that encounters the lead-out end of the audio session won't try to play the computer data.

Todd Rundgren, a well-known cybertainer in the music industry, is making his new CD, The Individualist, available only in CD+ format. Rundgren describes The Individualist (see the screen), which should be available by the time you read this, as a "multimedia album" designed to run on both PCs and Macs. With the CD in a multimedia desktop system, you get the equivalent of a music video with each song.

Major industry players—including Apple, Microsoft, Philips Electronics, Sony, and the Recording Industry Association of America, which is the trade group that represents U.S. record labels—have endorsed the CD+ Blue Book specification. Microsoft is also backing CD+ with its release of Symmetry, a CD+ development and authoring tool that supports WinG graphics acceleration, WinToon cartoon animation, and Surround Video. Macromedia (San Francisco, CA) also expects to release its Director Enhanced CD Toolkit for the Mac and Windows this fall.

However, CD+ is not the only interactive CD format. Content producers are also using ActiveAudio's Track Zero format, which was announced last year. Track Zero has advantages over CD+. Unlike CD+, which requires a multisession CD-ROM drive, Track Zero works on single-session CD-ROM drives as well. And although Microsoft says it will include full CD+ Blue Book support in Windows 95, the company hasn't said if it will support the format in Windows 3.1 or NT. ActiveAudio already has drivers for the Mac, as well as the three versions of Windows.

Whether they use Track Zero, CD+, or another format, these new interactive CDs are another example of how PCs and Macs are becoming entertainment appliances.

—**Greg Loveria**

Web Addresses for Interactive CD Information

For more information on Microsoft's latest lists of CD+-compliant multisession CD-ROM drives for Windows, go to: http://www.eden.com/cdplus/index.html.

Mac and PC users can view ActiveAudio releases at http://quicktime.apple.com/qtmusic.html and get additional information on the Track Zero specification at http://quicktime.apple.com/AA_MENU.HTM.

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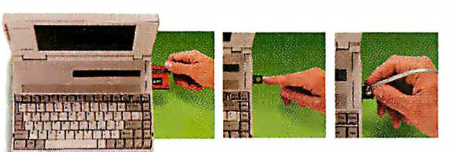
Barriers
- Increased weight
- Shorter battery life
- Higher cost

The number of notebooks with integrated CD-ROM drives will almost double in the next year, according to InfoTech, the international CD-ROM consultancy (Woodstock, VT). At the Computex show in Taipei, which should portend what you'll see in retail outlets this fall, practically every notebook vendor showed at least one CD-ROM-equipped portable. Sales of CD-ROM-equipped hand-held models will probably be less than notebook PCs, although InfoTech says gaming machines could change that forecast.

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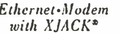
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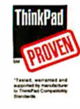
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NOTEBOOK TRENDS

Bigger LCDs Mean Better Images to Go

Bigger screens, more pixels. That's the trend in notebook screens as LCD manufacturers satisfy consumers' desire for bigger displays, especially for users whose notebook is their primary computer. The 10.4-inch VGA AMLCD (active-matrix LCD) is common in notebooks today, and some notebooks with bigger 11.3-inch passive-matrix displays such as the Austin Vista notebook from IPC Technologies (Austin, TX) are already available. Expect more 11.3-inch AMLCD notebooks to reach the market this year and next as screen manufacturers such as Hosiden, Sharp, NEC Electronics, Hitachi, and others achieve volume production.

Notebook displays that are larger than 11.3 inches diagonal will require a new notebook format. Apparently, that is what notebook vendors have in mind. Display manufacturer Mitsubishi Electronics America (Sunnyvale, CA) is working to redesign its existing 12.1-inch XGA (Extended Graphics Array) display to make it more suitable for notebooks.

"Various companies have informed us that there may be a new notebook size coming out in the next year or so that will take a 12.1-inch display," says Dale Maunu, product marketing manager at Mitsubishi. He declined to name specific companies. Screen manufacturers that will or already have 12.1-inch displays include Hosiden, Sharp, NEC Electronics, IBM, Hitachi, and Toshiba.

Because the 12.1-inch display offers about the same viewing area as a 14-inch CRT monitor, manufacturers also hope to sell some of these 12.1-inch displays with desktop computer systems. Expect to see these larger LCDs with high-end workstations where desk space is limited or mobility is important.

Displays that are 12.1 inches and larger are not a new item. Most display makers have made prototypes or are in limited production of larger-size displays. However, 12.1-inch displays are costly, power-hungry, and heavier than 10.4-inch displays. Screen manufacturers are working to reduce the cost and weight of the displays and improve performance. And notebook manufacturers are investigating ways to make their laptops lighter and thinner to accept the new large displays.

One way display makers hope to reduce the prices of their larger displays is through improving their manufacturing efficiency. Most manufacturers say larger motherglass sizes are the best way to improve efficiency, because more displays can be processed at the same time. To reduce weight, display makers plan to use thinner glass, more compact electronics that drive the video, and smaller backlight tubes.

"While the market demands smaller and lighter notebooks, it also wants the largest screen available," says Greg Gonzales, who is director of portable products at IPC Technologies ((800) 338-1571). "Our weight target is still under 6 pounds." Given those parameters, Gonzales says, the current strategy is to design notebooks that are wider, but about 1.5 inches thick, or about 0.5 inch thinner than today.

—Chris Chinnock

CODE TALK

RICK GREHAN

Microchip's a Hands-On Introduction to Fuzzy Logic

The fuzzyTech-MP Explorer ($295) is a combination of software and hardware for learning how to develop a fuzzy application. Though I have seen fuzzy logic applied to decision-making systems such as fuzzy-logic-based spreadsheets, the fuzzyTech-MP Explorer from Microchip Technology (Chandler, AZ, (602) 786-7200; fax (602) 899-9210) concentrates on using fuzzy logic in system control applications.

Microchip's fuzzyTech-MP Explorer includes hardware (shown) and software that lets you explore fuzzy-logic programming.

The hardware side of the Explorer is the fuzzyLab, a small circuit board powered by an AC adapter and populated with LEDs, push buttons, a pair of potentiometers, RS-232 circuitry, a socketed PIC-family processor, and a thermistor/resistor pair (bonded together in a plastic sheath). One output pin of the PIC processor is connected to the resistor. By varying the duty cycle of a pulse wave out that pin, you can heat the resistor. Via another I/O pin, the PIC processor reads the thermistor's temperature. The processor on the fuzzyLab "talks" through the serial port to the Windows-based fuzzyTech development system. The idea is to produce a fuzzy-logic control program that can heat the thermistor to a target temperature and keep it there.

This sounds simple, but fuzzyTech's tutorial will show you that this is not the case. In the tutorial, you operate the heating manually. I quickly discovered that when you turn the heater up too quickly, you overshoot the optimum temperature. If you back off too fast, it undershoots as it cools down. (I discovered that I would make a lousy thermostat.)

The next step is to activate the fuzzyTech development system. You define "crisp" values: real-world inputs and outputs (e.g., temperature and duty cycle). The crisp inputs are read into the system and "fuzzified" into linguistic terms: A temperature of 30°C might "fuzzify" into the linguistic term too_cold. Linguistic terms pass through a set of IF...THEN statements that you construct. These statements determine output linguistic terms. The output is "defuzzified" into a crisp output value that controls the amount of current going into the resistor.

All this time, you're learning fuzzy-logic fundamentals: how to define linguistic terms, how crisp input values convert to membership within linguistic terms, how output linguistic terms convert to crisp output values, and so on. Best of all, you can see if what you've learned works using the included fuzzyTech software.

The fuzzyTech development system provides a visual IDE (integrated development environment). Your system's details are all saved in an FTL (fuzzy technology language) source code file. Once your program works properly, you can output PIC16xx-compatible source code. (You need a separate product to assemble the source code into executable code.) You can even build a simulation in C and use fuzzyTech to control it. The product uses Windows messages as the communications route. Source code for this interface is provided. Microchip includes a sample program that uses this technique. It simulates using a crane to unload boat cargo and uses fuzzyTech to control the crane's motor. If you want to get your fuzzy feet wet, I can think of no better way than this.

ALL-IN-ONE COMPUTERS

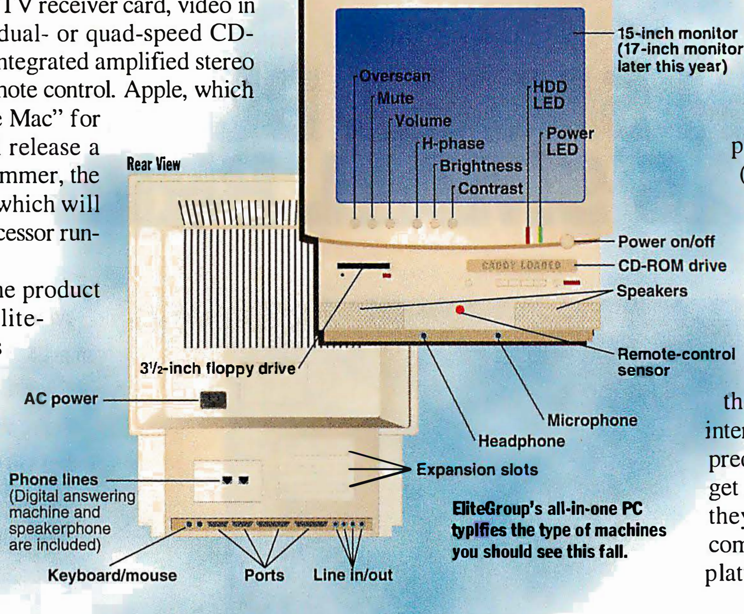
Computer-TV Hybrids Invade the Den

This fall, look for a wave of new PCs and Macs that integrate TV, stereo, and CD-ROM. At the fifteenth annual Computex Taipei exhibition, numerous vendors, including Acer, EliteGroup, Mitac, and Tatung (all from Taipei, Taiwan), showed PCs that typically integrate a 14- or 15-inch monitor, a 486- or Pentium-class CPU, a PCI (Peripheral Component Interconnect) bus, a TV receiver card, video in ports for VCRs, stereo, a dual- or quad-speed CD-ROM drive, 16-bit sound, integrated amplified stereo speakers, and, naturally, remote control. Apple, which already sells an "all-in-one Mac" for the education market, will release a system for the home this summer, the Performa 5200 CD series, which will include a PowerPC 603 processor running at 75 MHz.

Richard Chen, who is the product marketing director for EliteGroup Computer Systems (Taipei and Fremont, CA), which developed the Vertos system (see the figure), says these all-in-one computers will appeal to people in homes with limited space (e.g., in Japan) and to college students who are living in small dormitory rooms. He also says the all-in-one systems (aka monoputers) should be sold as the second, not the first, TV someone buys. "If retailers try to sell these as if they were a TV, people would wonder why they should have to pay $2500."

Combining a TV, stereo, telephone answering machine, and other appliances in a PC presents a challenge for the interface designer, says Karen Steinwachs, group product manager at Epson (Torrance, CA), which plans to release a monoputer this fall. "It will be interesting to see how the GUI and the remote control converge," she says.

"Vendors will have to integrate PC functionality with the normal home/audio way of interacting with devices." She also predicts that as all-in-one systems get 3-D graphics and 3-D sound, they will become even stronger competition to stand-alone games platforms such as Sega. —DA



EliteGroup's all-in-one PC typifies the type of machines you should see this fall.

BEST OF COMPUTEX

TAIPEI—The fifteenth annual Computex Taipei show held in June featured a wealth of PC, notebook, peripheral, and component introductions, many of which will reach the world's retail shelves this fall. Editors at BYTE and *0&1 BYTE*, which is the Chinese-language version of BYTE, surveyed the show to find the best hardware and software products. Here's what they found:

Best System (system motherboard or chip set)

Winner: The Flexus (+886 2 782 7292; fax +886 2 788 3862) 586F57, which is a high-speed Pentium motherboard that supports Pentiums running at up to 170 MHz internally.

Runners-up: Via Technology (+886 2 218 5452; fax +886 2 218 5453), for its green PC chip set, and AsusTek (+886 2 894 3447; fax +886 2 894 3449), for its P/I-P55TP4XE, which supports a variety of Pentium processors.

Best Portable:

Winner: Acer (+886 2 545 5288; fax +886 2 545 5308), for its AcerNote 950, which includes a 10.4-inch active-matrix screen, a built-in CD-ROM drive, a touchpad mouse, and an Intel Pentium chip.

Runners-up: Dual (+886 2 788 3919; fax +886 2 783 0023), for its 100-MHz Pentium-based PMD 5500 Pentimedia II with a built-in CD-ROM drive, and Kapok (+886 2 298 2651; fax +886 2 694 8787), for its notebook PC, which also has a CD-ROM drive.

Best Peripheral:

Winner: Up-Safe (+886 2 694 8181; fax +886 2 694 8787), for its DS-500 disk-size UPS (uninterruptible power supply), which fits inside a PC server's expansion slot.

Runners-up: ViewSonic ((909) 869-7976; fax (909) 869-7958), for its 15GA 15-inch multimedia monitor with built-in microphone and speakers, and MicroTek's (+886 35 772155; fax +886 35 772598) PageWiz 300-dot-per-inch scanner.

Multimedia Hardware:

Winner: Umax (+886 2 517 0055; fax +886 2 517 2017), for its 192-bit MaxMedia CD/Pro graphics accelerator card, which uses three 64-bit graphics chips.

Runners-up: Acer's Vuego six-speed CD-ROM drive; Aver (+886 2 226 3630; fax +886 2 221 4538), for its live-video frame-grabber board for PCs, and LeadTek (+886 2 248 4101; fax +886 2 248 4103), for its Proview GD 400 3D graphics card, which uses Nvidia's NV1 multimedia accelerator chip.

Multimedia Software:

Winner: U-Lead (+886 2 764 8599; fax +886 2 764 9599), for Media Studio Pro 2 integrated multimedia editing software for Windows.

Runners-up: Prolab (+886 2 517 0750; fax +886 2 517 0760), for Media Folio, which is an image-processing, video-processing, and authoring tool you use with Windows; and Far Stone's (+886 2 777 2435; fax +886 2 777 1720) SmartCD Instant software, which is a plug-and-play CD player for all CD-ROM drives.

Connectivity:

Winner: D-Link (+886 2 916 1600; fax +886 2 914 6299), for its DFE-812TX100Base Hub and DFE 500TX 10/100-Mbps PCI (Peripheral Component Interconnect) Fast Ethernet Adapter.

Runners-up: CNet (+886 35 785158; fax +886 35 785159), for its CN9100 Ethernet-to-ATM (asynchronous transfer mode) switching hub, and Moxa (+886 2 910 1230; fax +886 2 910 1231), for its asynchronous terminal server.

International Product:

Winner: Logitech (+886 2 746 6601; fax +886 2 762 1943), for its Fotoman Pixtura digital camera.

Runner-up: Miro (+886 2 999 8116; fax +886 2 999 8140), for its miroVideo DCI TV multimedia special-effects system.

—Katie Sung

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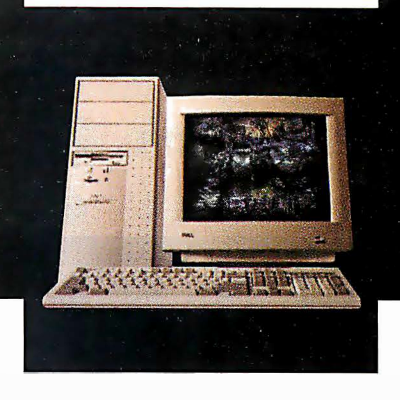
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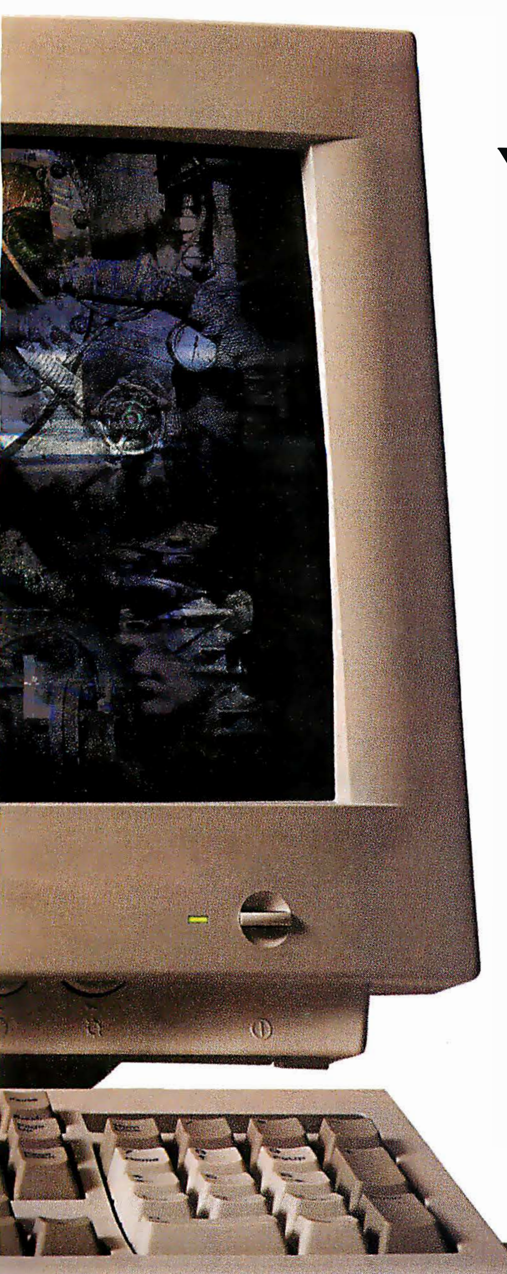
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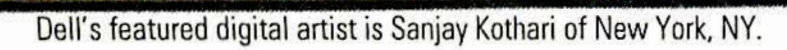


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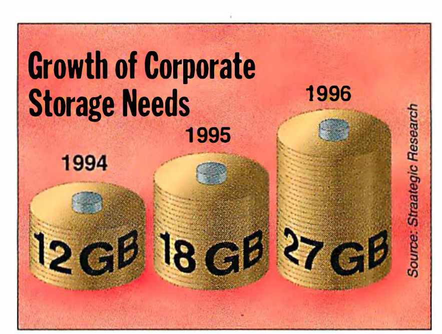

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STORAGE TRENDS

Coming: Better Data Management Tools

The demand for increased storage capacity never seems to end. And this ever-increasing demand brings a need for tools to better manage the data.

The growing use of client/server applications and the downsizing of legacy applications to LANs are two prominent contributors to increased storage requirements. Today, companies typically store about 18 GB of data on their LANs (see the figure "Growth of Corporate Storage Needs"), according to Strategic Research (Santa Barbara, CA).



Additionally, data-storage requirements are increasing as users download files from the Internet. The size of downloaded files is also increasing as users download graphical files from the World Wide Web as well as WAV and AVI files, which can be large. About 42 percent of users say they typically download files that are 2 to 5 MB in size, 19 percent say they typically download files between 5 and 10 MB, and 9 percent say the typical file size is between 50 and 100 MB. This is according to a survey of 300 users conducted for 3M by Fleishman-Hillard Research.

All this downloading and downsizing has sparked a demand for integrated data backup, restoration, and migration tools. Typically, PC and network utility software vendors developed such tools. But now, companies known for their data-storage hardware products are getting into the act.

Within the last year, Seagate Technology (Scotts Valley, CA) has acquired Palindrome (which sold data backup and management systems) and Frye Computer (which sold network and system management software). And 3M's Data Storage Tape Technology Division (St. Paul, MN) is working with developers to bring simpler data management tools to the desktop user.

Seagate's actions illustrate the trend to integrate data management with network management. Other companies, notably IBM and Microsoft, are also active in this field with their systems management efforts. Combined data/network management tools yield numerous synergies. One example is that you can link an HSM (hierarchical storage management) system to a network traffic-analysis product so that a large-scale file migration is delayed if a traffic-analysis tool senses the network is stressed. Additionally, if the two types of tools are linked, your backup program could monitor hard drive capacity and send an alert to a network management console when a disk approaches a threshold level.

In some ways, the 3M efforts target the other end of the scale: the desktop user. For example, one alliance 3M has is with Chili Pepper Software (Atlanta, GA), developers of Infinite Disk, an HSM-based file management package used with 3M's Travan minicartridge tape technology.

Most HSM packages on the market are designed for network administrators to use and are fairly complex. But because Chili Pepper designed its program for the desktop user, Infinite Disk is easier to use than other programs. For example, one feature lets you designate how much hard disk space you need freed up when loading a large application. The program lets you enter the amount of disk space required by the application and then lets you specify how to move files off the hard drive. For example, you can specify TIFF and BMP files not used in 30 days.

Another desktop data management software product that will be available later this year comes from a 3M alliance with PGSoft (Pacific Grove, CA). The new utility lets you transfer, record, and play back data, audio, video, and other types of multimedia files without having to move them onto a hard drive.

Essentially, a tape drive appears as a "T" drive to the system, letting you click on a tape icon in File Manager to see what files are on tape or to drag and drop files in either direction (tape to hard disk or vice versa). You can open any file on the tape as you normally would (as if it were on the hard drive). This feature is handy for CAD users who don't want to make room for a large file every time it's needed. Opening files off the tape drive is slower than opening a file on the hard drive, but 3M uses caching techniques to reduce the performance hit.

Data backup, restoration, and migration tools have been around for many years. But the complexity of many of the products and the continuing explosion in the amount of data that must be managed are prompting the industry to develop easier-to-use tools for both the network administrator and the desktop user.

—Salvatore Salamone

NEW 4.6-GB OPTICAL DRIVE CHALLENGES MAGNETIC

Pinnacle Micro (Irvine, CA) expects to release a new MO (magneto-optical) drive this month that's less expensive than magnetic hard drives. Also, it offers performance improvements over previous MO drives. Pinnacle says that with the new performance improvements, its 4.6-GB Apex drive will compete directly with magnetic hard drives as a primary storage medium. The Apex features removable storage cartridges and is also compatible with current 2- and 2.6-GB MO drives.

One improvement Pinnacle made is in data transfer speed. The company uses the same high-speed read-channel ICs (with some tweaking to support the optical format) found in magnetic hard drives to gain a respectable 6-MBps data transfer rate. The higher 4.6-GB data density is achieved by slightly increasing the recording area on the disk (without increasing the actual size of the 5¼-inch disk), using smaller-size bits to store data, and using smaller heads. The smaller heads also helped lower the seek time to between 15 and 17 milliseconds. And Pinnacle lowered the time required to write data to the drive by implementing direct overwrite instead of the two-pass write operation used in other MO drives.

The Apex may prove popular as a stand-alone storage device for power users as well as in optical jukeboxes. At a list price of $1695 (which includes a 4.6-GB cartridge), the drive offers a cost per megabyte of 37 cents compared to 58 cents per megabyte for a $2500 4.3-GB magnetic hard drive.

Ray Freeman, an analyst at storage consultant Freeman and Associates (Santa Barbara, CA), says the Apex drive will be "immensely attractive" if it lives up to its advance billing. Says Freeman, "The Apex should stimulate additional demand for optical storage and generally give optical storage a shot in the arm."

—DA

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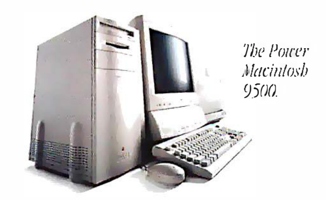
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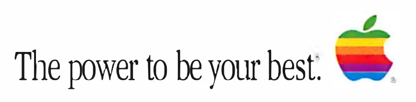
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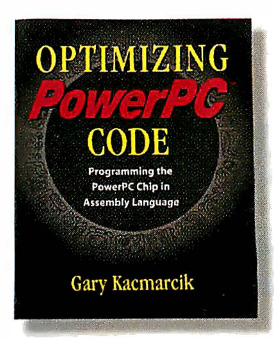
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How to Optimize Your PowerPC Code

TOM THOMPSON

The PowerPC market is growing, and many books covering the programming of this processor are being published. *Optimizing PowerPC Code* by Gary Kacmarcik tells how to write faster native code. The book starts with functional descriptions of the PowerPC 601's architecture and instruction set. The author describes such features as cache operation and branch prediction logic.

Once this groundwork is complete, Kacmarcik moves on to optimization tricks. Some of these are standard fare: using right shifts to replace multiply operations and multiplication to replace expensive divide operations (for numerous divide operations, multiplying with a reciprocal is faster). Other tricks involve mixing the instruction stream so that all the execution units are kept busy and avoiding pipeline stalls by modifying certain code structures, such as loop unrolling and code pasting (i.e., placing code-block duplicates elsewhere in an algorithm to increase the number of independent instructions that can be sent to execution units). Finally, there are nitty-gritty details about specific register dependencies and what can be done to avoid them.

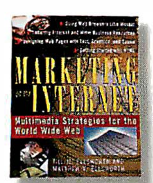
It's important to note that this subject is discussed at a fairly high level. For example, the loop-unrolling examples are in C, although certain sections are peppered with assembly language output. Also, there's no treatment of development tools or a specific machine environment (e.g., the Power Mac's code implementation). However, the broad treatment Kacmarcik uses lets these techniques be applied to all PowerPC systems.

OPTIMIZING POWERPC CODE

Gary Kacmarcik
Addison-Wesley
ISBN 0-201-40839-2

$39.95

Tom Thompson is a BYTE senior technical editor at large who is the author of Power Macintosh Programming Starter Kit *(Hayden Books, 1994). You can reach him on AppleLink as T.THOMPSON or on the Internet or BIX at tom_thompson@bix.com.*



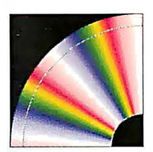
ESTABLISH A WEB BEACHHEAD

MARKETING ON THE INTERNET: MULTIMEDIA STRATEGIES FOR THE WORLD WIDE WEB by Jill H. Ellsworth and Matthew V. Ellsworth
John Wiley & Sons, ISBN 0-471-11850-8, $24.95

In the search to find yet another angle for an Internet book, the Ellsworths key off the current hot topic: commerce on the Net. Unfortunately, the book never addresses the question of how profitable on-line companies are. Instead, the authors quote gee-whiz statistics about how fast the Net is growing and imply that growth equates to profits for companies on the Net. Buying studies have yet to prove that's true, however.

But if you're a true believer in Net commerce, or are afraid that you're letting a business opportunity slip by, this book provides a handy starting point for establishing your company on the Net. At its best, the book offers practical advice on what makes a home page attractive and easy to navigate. At its worst, it's a rehash of Net introductory material that you'll find in dozens of other books.

Most appealing are the step-by-step examples of HTML (Hypertext Markup Language) code that show you how to format ASCII text and embed hypertext links for documents you want to publish on the Net. The authors also show how the same HTML text appears when viewed by different Web browsers. The core of *Marketing on the Internet: Multimedia Strategies for the World Wide Web* offers solid advice for businesspeople itching to establish a Web site. But, like the Net itself, you'll have to sift through some extraneous material to get to the good stuff. ■ —*Alan Joch*



SHOOT POOL AND/OR RELIVE THE SIXTIES

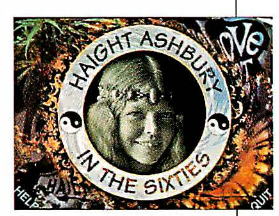
VIRTUAL POOL Interplay Productions, 17922 Fitch Ave., Irvine, CA 92714, (714) 553-6655, $39.95

If you like to play pool, you'll love the Virtual Pool CD-ROM. Its developers really sweated the details. All the physics of the real game are there, such as friction, cushion response, and cue ball spin. You can line up a shot by "walking" around the table, move closer, back away, and even attempt a trick massé shot.

In addition to eight-ball, you can play nine-ball, rotation, straight pool, and snooker. You can play against your computer, against a friend, or with other players via a modem or over a network. Virtual Pool runs under DOS 5 or higher on PCs with at least a VGA card, 2 MB of RAM, 2 MB of hard disk space, and a Sound Blaster–compatible sound card.

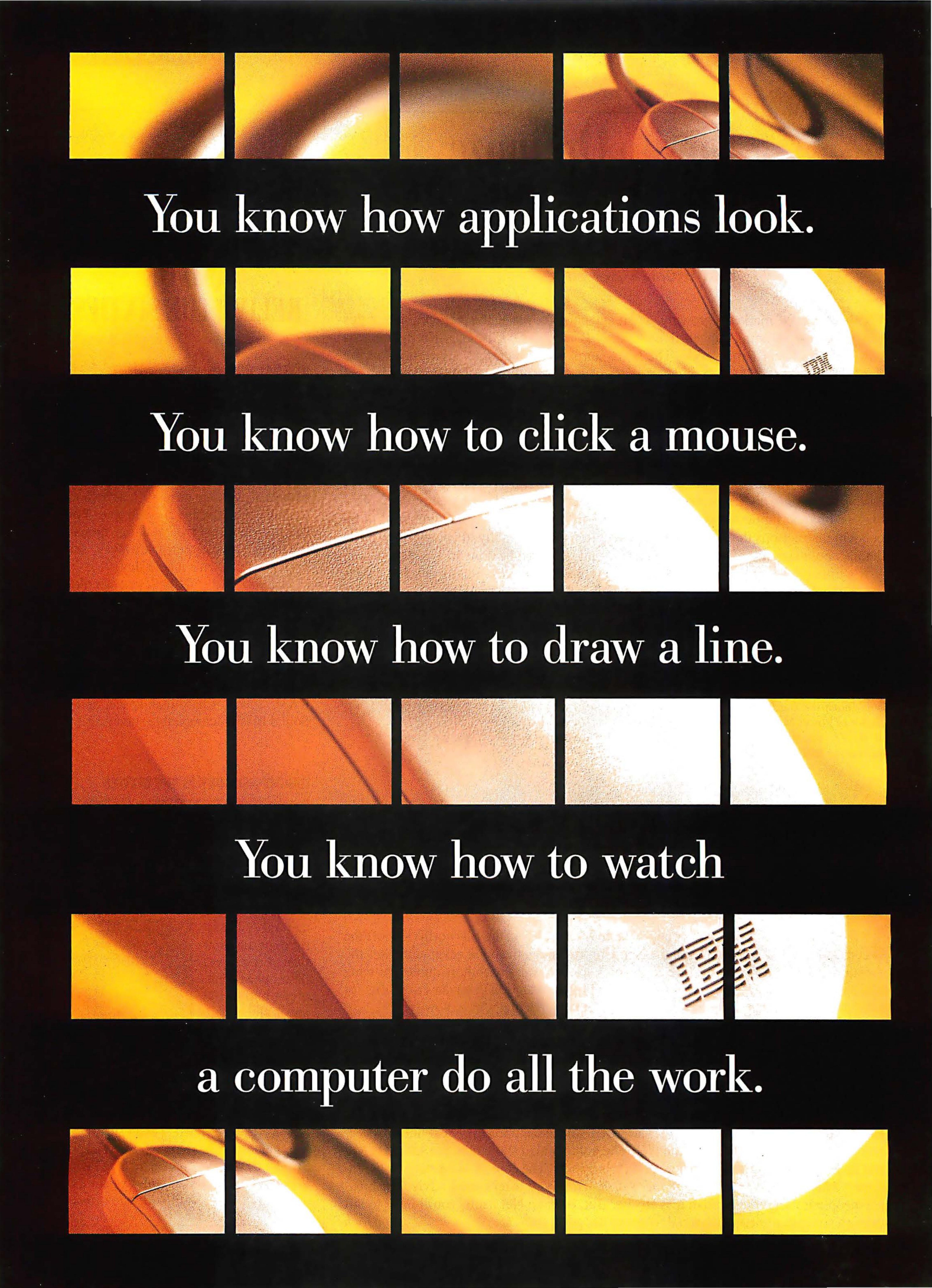
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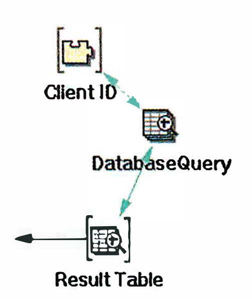


A time of youth rebellion.

—*Rich Friedman*



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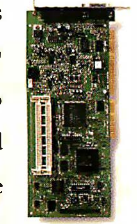
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Assets on the Line

SALVATORE SALAMONE



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Computer asset management, using automatic hardware and software systems, can simplify administration and save money

You're planning a big vacation trip, so you call Human Resources to see how many vacation days you have. "Well, we don't know exactly—somewhere between 10 and 20." Makes it somewhat hard to plan, wouldn't you say?

Strangely enough, IS managers trying to support end users are in a similar situation. They often lack accurate—and essential—information about the quantity and types of hardware and software their users are working with.

The vendor community has responded to the demand for such inventory information with a multipronged approach. Some software utility vendors, such as Frye Computer Systems (recently acquired by Seagate), Horizons Technology, McAfee Associates, Microsoft, Microsystems Software, Saber Software, Symantec, and Tally Systems, offer asset management software that performs hardware and software inventory of network-attached PCs, Macs, workstations, and servers.

The DMTF (Desktop Management Task Force), which is an industry consortium of hardware and software vendors, has developed a specification that provides a standard way to inventory computer equipment over a network. Today, DMTF-compliant products are finding their way to market.

Server and PC manufacturers, such as AST, Compaq, Dell, and NEC, are beefing up their products by adding firmware that performs a hardware inventory and makes this information available to network management programs.

Finally, if you don't want to do it yourself, outsourcing firms that specialize in network management, such as NetSolve and Hewlett-Packard's service organization, shrewdly offer configuration and asset management services as well.

Counting the Beans

All these alternatives aim for the same goal: a more accurate picture of the hardware and software throughout an organization, based on the detailed inventory information they collect. Traditionally, such inventories have been performed by hand—with a screwdriver—going from desktop to desktop. But such manual inventories have countless drawbacks.

Labor is required to perform an inventory, typically half an hour per PC, according to the PC Asset Management Institute. For one or two PCs, that's OK. But for a less modest collection of 2000 PCs, that means 1000 hours, or half a year for a full-time IS staffer doing nothing but inventory. Major snore, major expense.

A second disadvantage to manual inventory is that the information collected quickly becomes outdated. The once-a-year inventory becomes obsolete as soon as a user installs a sound card.

It's little wonder that most organizations either have no inventory or use an outdated one. As a result, they are constantly performing ad hoc inventories every time they need accurate information—whether buying memory to upgrade PCs or merely

Looking Under the Hood

The DMTF (Desktop Management Task Force) has finalized its DMI (Desktop Management Interface) specifications that, once adopted by equipment manufacturers, will make hardware inventory easier. Over 150 vendors have already pledged support for the standard.

Basically, DMI defines a format of a management agent for desktop systems. Its layered-model architecture (see the figure) allows a wide range of software and hardware components to pass information about themselves to an asset management system. The layers include an MI (Management Interface), a Service Layer, a CI (Component Interface), and MIFs (Management Information Formats).

The MI passes requests for information (1) from the asset management system to the device. Each component has a vendor-supplied MIF that describes the device. The Service Layer (2) uses the device information stored in an MIF database (3) to interpret what is being requested. The CI (4) makes calls to component management software routines, which, when run, yield the information (5) requested by the asset management system.

Desktop Management Interface

troubleshooting a problem on a single PC.

Whatever the reason, according to a survey of 106 network managers conducted by Infonetics Research (San Jose, CA), companies spend an average of 40 hours per month performing asset and inventory management. Put another way, a week's salary is spent every month for such impromptu inventories.

Enter the Robot

For these reasons, it makes sense to automate as much of the inventory process as possible. That's most often what the products from software utility vendors do. Typically, asset management programs, such as Norton Administrator for Networks 2.0 from Symantec and NetCensus from Tally Systems, automatically collect detailed hardware and software inventory from servers and nodes on a network.

These products run in different networking environments (see the table "Asset Management Software"). Some are NLMs (NetWare loadable modules) and run only on Novell NetWare LANs. Others are NOS-independent (network operating system).

Programs that inventory hardware collect information about a wide range of hardware components (see the screen on page 40). This includes processor type, disk drives, BIOS, serial and parallel ports, installed RAM—even the network adapter card, and whether a mouse or game port is installed.

Programs that inventory software collect information about the system files, drivers, and applications installed on machines, including version number and the date and time applications were created.

Automatically collecting hardware and software inventory information has typically required proprietary approaches. Often, hardware inventory programs use a custom-developed TSR program running on each PC that queries the machine's hardware and passes this information to a server-based inventory program.

For software inventory information, most vendors take a brute-force approach and simply compile lists of hundreds to thousands of common programs, typically including the name of each executable file as well as its size and date. The inventory program simply looks for executable files and compares the name, size, and date to the list to determine what versions of what programs are installed. A number of tricks make sure the version number is correct, including checking the time stamp, because many applications set that time to the version number. For example, the executable files for Norton Desktop for Windows 3.0 carry a time stamp of 3:00 a.m.

While these techniques instantly inventory equipment attached to a network, laptops and stand-alone computers typically run a separate program. It saves inventory information on a floppy disk that can be sneakernetted and incorporated into the corporate inventory database.

Stand and Deliver

These methods for taking inventories of hardware and software work fine to a point. If only these products would become more assertive and tell asset management systems more about themselves. For example, hardware components should be able to identify themselves to an asset management system, rather than having to run a TSR on every machine.

Two industry initiatives are tackling this goal. For software inventory, LSAPI (Licensing Service API) includes program

ASSET MANAGEMENT SOFTWARE

COMPANY	PRODUCT	NOS SUPPORT	CLIENTS SUPPORTED	INTEGRATED WITH UPPER-LEVEL MNGT. SYSTEM?
Frye Computer Systems, Inc.	Smart	NetWare	DOS, Windows, OS/2, Macintosh	Yes
Horizons Technology, Inc.	LANauditor	NOS-independent	DOS, Windows, OS/2, Macintosh	No
McAfee Associates, Inc.	LAN Inventory	NetWare	DOS, Windows, OS/2, Macintosh	Yes
Microsoft Corp.	Systems Management Server	NT, NetWare	DOS, Windows, OS/2, Macintosh	Yes
Microsystems Software, Inc.	Software Sentry	NOS-independent	DOS, Windows	No
Novell and Intel	Managewise	NetWare	DOS, Windows	Yes
Saber Software Corp.	Saber Enterprise Application Manager and LAN Workstation	NetWare	DOS, Windows, OS/2, Macintosh	Yes
Symantec Corp.	Norton Administrator for Networks	NOS-independent	DOS, Windows	Yes
Tally Systems Corp.	NetCensus	NOS-independent	DOS, Windows	No

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Hardware Inventory–Parts

	Part	Desciption
10	GAMEPORT	No
11	HARDDISK0	Type: 16 Size 204MB
12	HARDDISK1	Type: 0 Size: 0MB
13	PX	Ipx Ver. 3.10 Shell Ver. 3.26 Rev. A
14	LANCARD	Type: Intel EtherExpress(tm) 16 v1.09EC 91C905
15	LANCARDCFG	Configured at IRQ = 10, I/O = 360h
16	MOUSE	Yes
17	NETADDRESS	00A400' 4FD30
18	NETBIOS	No

Asset management programs, such as Saber's LAN Workstation (shown here), typically display a wide variety of configuration information.

calls that provide a common way for applications to pass licensing information to an inventory or metering function. The inventory function itself can be either part of a NOS or a third-party utility program.

Microsoft and Novell plan to include LSAPI in their OSes. Other interested vendors include Apple Computer (Cupertino, CA), Banyan Systems (Westborough, MA), Digital Equipment (Maynard, MA), Lotus Development (Cambridge, MA), McAfee Associates (Santa Clara, CA), Oracle (Redwood Shores, CA), and WordPerfect (Orem, UT). As with most standards, adoption of LSAPI has been a slow process. However, once LSAPI is commonly deployed in applications, it will be easy for administrators to identify software on their networks.

On the hardware inventory front, the DMTF is leading the way with the DMI, which specifies a common way of accessing the hardware and software components in a desktop PC. DMI lets management systems access the information about a PC's internal components. The DMTF's CAPI (Common API) will simplify writing applications that access information about a machine's innards (see the text box "Looking Under the Hood" on page 38).

Heavyweight members of the DMTF include Digital, HP, IBM, Intel, Microsoft, Novell, and SunConnect. Most major PC manufacturers, including AST, Compaq, Dell, and NEC, are incorporating DMI-compliant components into their PCs.

The fourth inventory method, as mentioned above, involves outsourcing vendors who are gearing up to provide inventory and asset management services. Such companies say they will charge between $3 to $8 per box per month for inventory services. For an organization with 2500 PCs, that translates to $90,000 to $240,000 per year.

Benefits Aplenty

That's a lot of money to pay outsiders just to take inventory. Why would anyone pay so much for something that simple? Probably to save money in the long run. After all, a typical PC's purchase price accounts for only about 12 percent of the total cost of ownership over its lifetime, according to the Gartner Group. The other 88 percent covers administrative factors, such as inventory, training, and auditing costs. A 1994 survey of the Help Desk Institute found that 82 percent didn't know how much each support call cost them. Guesses ranged from $1 to $75. According to a survey of 180 large user organizations conducted by Business Research Group (Newton, MA), LAN support costs $778 per user per year on NetWare LANs. A Forrester Research (Cambridge, MA) study found that, for a 5000-user network, it costs three times more to support LAN users than it would to support those same users on an SNA (Systems Network Architecture) network.

Only within the last few years have such recurring management costs become an issue. Before that, the true costs of managing PCs and LANs were hopelessly scattered among numerous departmental operating budgets. But as organizations have recently tried to regain control of departmental LANs, these costs have been consolidated into one operating budget, and the magnitude of the expense has become horrifyingly apparent.

Many companies can also reduce support expenses by ensuring that products still covered by warranties are serviced by their vendors. And warranty information can easily be stored in a company hardware inventory database.

Asset management information can identify trends and head off problems before they occur. For example, by using equipment service histories (stored in an asset management database) to become proactive in preventive maintenance, a company can cut costs for emergency repairs.

So, what's an effective asset manager to do? First, it is to your advantage to buy DMI-compliant products (and insist that vendors offer them). Second, you can simplify many lives by looking for inventory programs that link into help-desk systems or higher-level management systems. Third, despite the overt expense, consider outsourcing the process if your staffing levels are low.

The bottom line is that costs to support computer software and hardware dwarf the purchase price. Asset management can provide information that is key to reducing those costs, and maybe make that vacation happen after all. ■

Salvatore Salamone is a BYTE news editor based in New York and author of Reducing the Cost of LAN Ownership *(Van Nostrand Reinhold, 1995). You can reach him on the Internet or BIX at ssalamone@bix.com.*

Product Information

LANauditor $495 for 50 users
Horizons Technology, Inc.
San Diego, CA
(800) 828-3808
(619) 277-7100
fax: (619) 292-9439
Circle 1228 on Inquiry Card.

LAN Inventory $699 for 100 users; $999 for 250 users
McAfee Associates, Inc.
Santa Clara, CA
(800) 866-6585
(408) 988-3832
fax: (408) 970-9727
Circle 1229 on Inquiry Card.

Managewise $795 for five-user license; $6975 for 250 users (combines Novell's NetWare Management System and Intel's LANdesk Manager)
Novell, Inc.
Provo, UT
(800) 453-1267
(801) 429-7000
fax: (801) 429-5155
Circle 1230 on Inquiry Card.

Intel Corp.
Santa Clara, CA
(800) 548-4725
(408) 765-8080
fax: (408) 765-1821
Circle 1231 on Inquiry Card.

NetCensus $10 to $20 per PC depending on the number of licenses
Tally Systems Corp.
Hanover, NH
(800) 262-3877
(603) 643-1300
fax: (603) 643-9366
Circle 1232 on Inquiry Card.

Norton Administrator for Networks 2.0 $58 per node for 100-user license; $44 per node for 1000-user license
Symantec Corp.
Cupertino, CA
(800) 441-7234
(408) 253-9600
fax: (408) 252-4694
Circle 1233 on Inquiry Card.

Saber Enterprise Application Manager $695 per server
Saber Software Corp.
Dallas, TX
(800) 338-8754
(214) 361-8086
fax: (214) 361-1882
Circle 1234 on Inquiry Card.

Smart $495 for 100 users; $3795 for 1000 users
Frye Computer Systems, Inc.
Boston, MA
(800) 234-3793
(617) 451-5400
fax: (617) 451-6711
Circle 1235 on Inquiry Card.

Software Sentry $595 for 250 users
Microsystems Software, Inc.
Framingham, MA
(800) 489-2001
(508) 879-9000
fax: (508) 626-8515
Circle 1236 on Inquiry Card.

Systems Management Server $649 per server
Microsoft Corp.
Redmond, WA
(800) 426-9400
(206) 882-8080
fax: (206) 936-7329
Circle 1237 on Inquiry Card.

You Can Take It with You

JEFFREY FRITZ



ANDREA BARUFFI © 1995

ISDN and other digital services provide more ways to connect users to corporate networks

Remote access used to be the lifeline you clung to in your hotel room after you realized your presentation was home alone on your hard drive 3000 miles away. But today, remote-access networks are the foundation for companies that don't see corporate headquarters as ground zero anymore. Just as much action is taking place in the field, on the road, or in branch offices.

The trick is to select the right technology or mix of technologies that can make it easy for far-flung workers to reliably connect to your company's main network. More and more, digital-service WAN technologies are becoming part of this mix because they're faster and more dynamic than T-1 or 56-Kbps leased lines.

But even today, no one-size-fits-all solution exists for all companies, and venerable technologies still play a role in WAN connections. Your choices will depend on whether you need full-time point-to-point connections for a branch office, or more temporal connections for mobile workers or telecommuters. Many companies require a combination of these two choices.

Remote Gets Real

The need for efficient remote access has grown in part because work can get done faster if you're closer to a customer site, or because workgroups are better if they're built on expertise rather than on geographical proximity. Either way, employees throughout an enterprise need to make business decisions with the same data that's available at headquarters.

Alternately, people in the home office often need immediate access to the expertise of workers in the field, who may be able to spot business trends faster than those in a central location. In addition, telecommuting is becoming a way of life for more and more people. LINK Resources Corp., a New York-based market research firm, says the U.S. work-at-home market grew to more than 40 million people last year.

Digital technologies shine in those applications because of high throughput. Basic ISDN service, for example, provides for bandwidth of 128 Kbps, while a less commercialized technology such as ATM (asynchronous transfer mode) can scale up to more than 600 Mbps. Although 128 Kbps can seem like a narrow pipe for LANs, WAN devices can make the most of it with compression and filtering. At the same time, network administrators can use protocol filtering to reduce superfluous traffic over the WAN, especially by eliminating multicast and broadcast packets. Address filtering allows only packets addressed to the remote destination to pass across the WAN. If filtering and compression are not enough, digital devices, including those for ISDN, can provide additional bandwidth-on-demand by automatically allocating and binding extra channels based on current traffic requirements.

Cutting Costs with Contention

Digital dial-up connections make sense in another way: They reduce the amount of line-termination equipment a company

must purchase. With leased lines, there is one-to-one correspondence between devices (such as bridges or routers) in the field and allocated ports in the central or hub site. Frequently, network managers use the ratio of devices in the field to available ports at the hub as a way to size up their network connections. This ratio, called *contention*, is based on the assumption that all users will not simultaneously try to connect to the enterprise.

Contention reduces the amount of money you have to spend on lines and hub equipment. For example, a company might have 400 telecommuters, but no more than 50 are expected to be on line at any given time. Rather than installing 400 network ports at the enterprise hub, the company can connect 50 ports in a "roll down" configuration—8:1 contention. Users dial a common telephone number and connect to the first available port. When the fifty-first caller attempts to connect, he or she will get a busy signal and will need to attempt the connection later. (In some advanced hubs, an administration program keeps track of call attempts. When a hub port opens up, the unit will call the remote user back.)

Finding the optimal contention ratio is an iterative process. Setting contention too low wastes resources and is unnecessarily expensive. Setting contention too high results in call blocking and user frustration. Typically, network administrators will make a conservative guess and monitor access requests to see if the contention threshold is realistic. Once an administrator has some feel for typical usage, contention can be fine-tuned as needed.

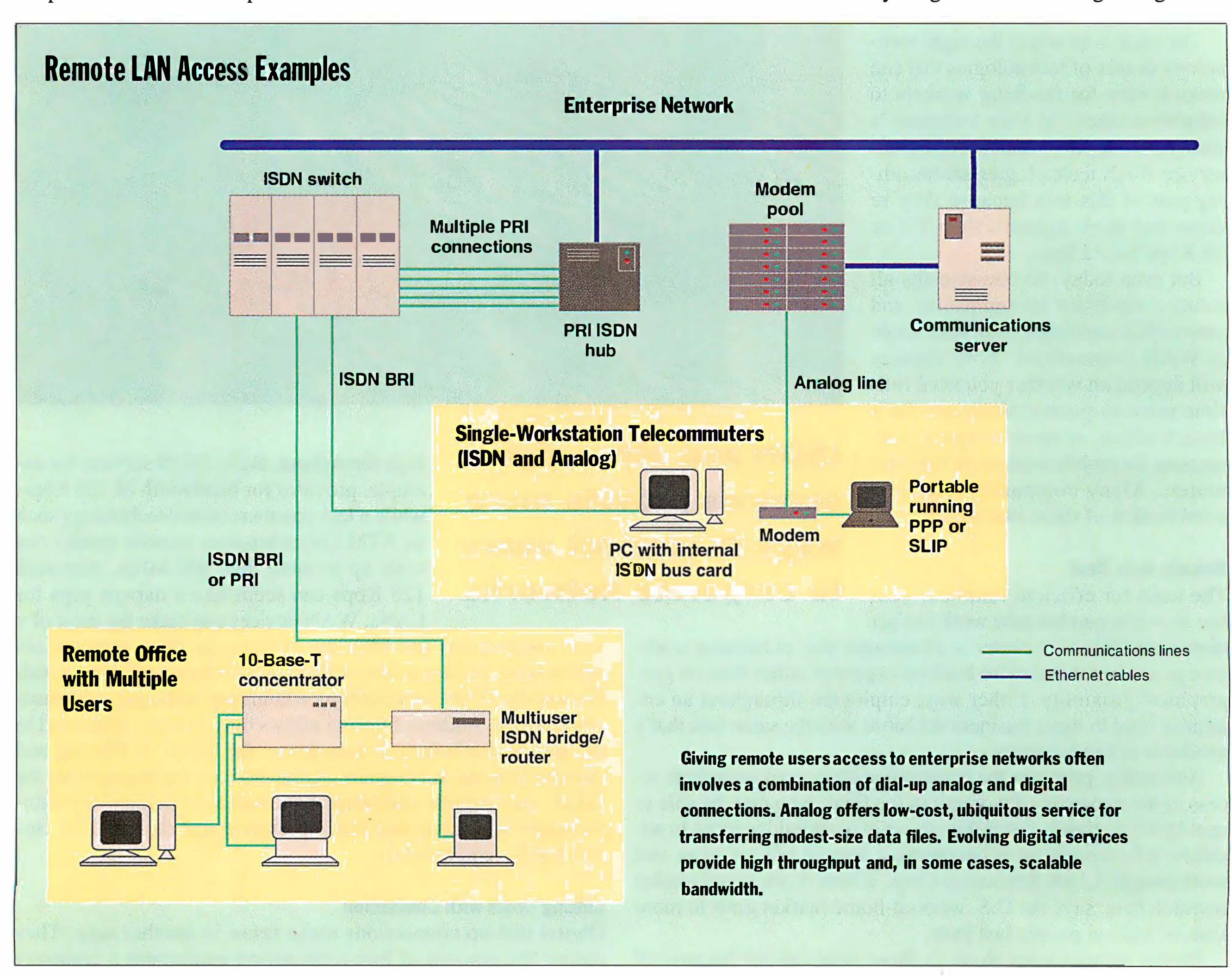
Permanent Connections

Despite the performance advantages of digital technologies, it's not always easy to determine the price/performance cut-over point between leased lines or analog phone lines and digital links. T-1, at 1.544 Mbps, or 56-Kbps leased lines are the traditional ways to connect branch offices to a headquarters' LAN. Leased lines are particularly advantageous if you can count on a stable level of communications activity, which will help you cost-justify this type of connection. That's because leased lines operate at a fixed monthly cost, no matter how much data you're pumping through them. Leased lines are an economical choice if you can find a way to constantly use them; for example, by making them communications links during business hours and data pipelines during the night to update corporate databases.

However, life isn't always predictable enough for leased lines. Your company may need connections to remote offices for only a few hours a day. In this case, high-speed modems (which we'll discuss later) or switched digital networks are better choices than leased lines. Switched networks establish connections only when the need to communicate exists. When there's no communications, the line shuts down and charges are no longer incurred.

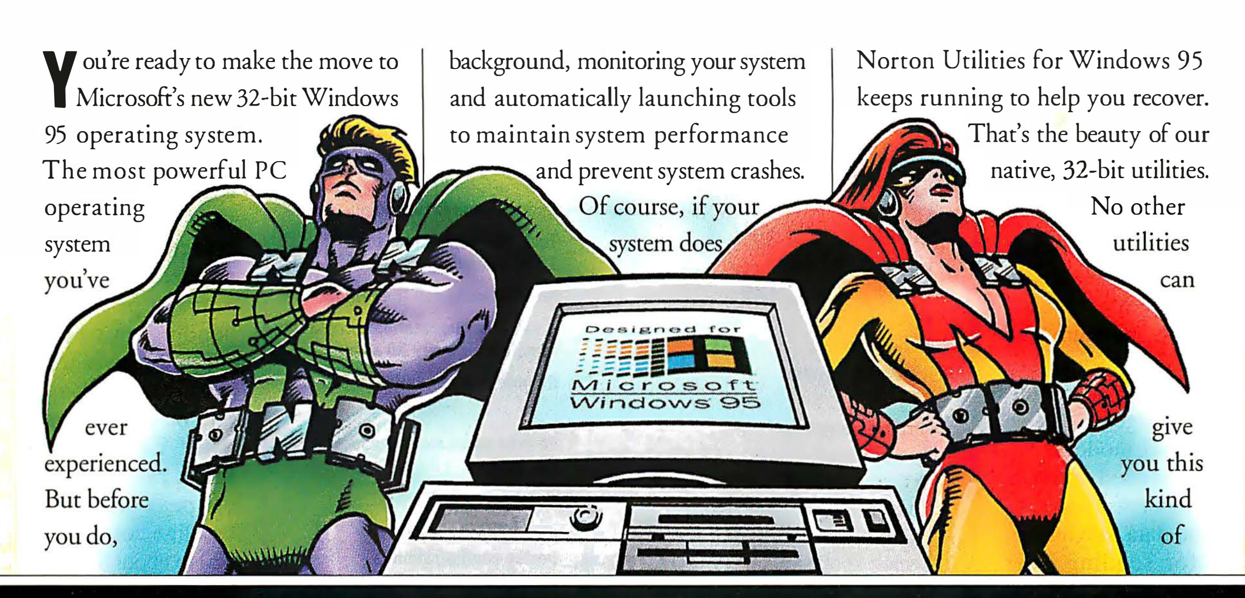
ISDN's Promise

In areas where it's available, ISDN is particularly suited for remote access because it can build upon traditional dial-up strategies where users dial in with modems over analog phone lines. ISDN can handle everything from connecting a single user



Giving remote users access to enterprise networks often involves a combination of dial-up analog and digital connections. Analog offers low-cost, ubiquitous service for transferring modest-size data files. Evolving digital services provide high throughput and, in some cases, scalable bandwidth.

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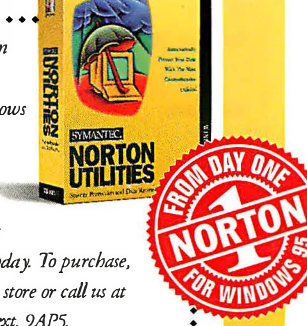
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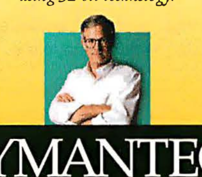
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(at higher data rates than when using a modem) to providing enhanced connections of LANs at different sites (see the figure "Remote LAN Access Examples" on page 42). In this situation, you establish connections on an as-needed basis rather than having to pay for an idle pipeline, as with a leased line. Also, the call setup time for ISDN can happen in milliseconds, which avoids unnecessary charges.

Traditional modems establish as-needed connections, but modems must convert digital data into analog signals for sending over phone lines. The ISDN difference is that every step of the communication is digital. Basic Rate Interface, or BRI, is the baseline ISDN service. It offers two B (bearer) channels of 64 Kbps each for combined throughput of 128 Kbps. (Primary Rate Interface, or PRI, offers 23 B channels.)

Typical Configuration of a Hub Site ISDN Bridge

Configuration parameters:		
Switch type	5ESS	Set up for AT&T 5ESS switch using custom translators
ISDN type	Custom	
Callback	OFF	Callback of remote user is off
Line speed	64K/line	
Protocol	COMPRESSED	Compression is turned on
Address age time	1000	Toss addresses older than 1000 seconds
Connection type	Auto on	Automatically call the remote user
Packet time-out	OFF	
Retry delay	30	If call is unsuccessful, try recalling remote user every 30 seconds
Called number	2935555	Remote bridge number
Ringback number		
Security parameters:		
Access status	ON	Remote users can access the device
System password	Exists	
Client password	None	
Callback security	OFF	
Remote configuration	PROTECTED	Device configuration is password-protected
Protocol filtering:		
C806	ACCEPT	Pass these Ethernet protocol types to the remote user; filter all other protocols
809b	ACCEPT	
80f3	ACCEPT	
Type of forwarding mode is ONLY		
Type of demand mode is ANY		
Number of Ethernet addresses:	20	Bridge knows about 20 current Ethernet addresses

ISDN is a multiple-channel service with built-in packet capability, lending itself extremely well to WAN access. Unfortunately, ISDN's benefits don't always come easily or inexpensively. Ordering ISDN service can be a nightmare. Some regional phone companies are still developing expertise with the technology, and you have to make sure the service you receive matches the requirements of your ISDN hardware (for details on these two issues, see "Implementing ISDN," April BYTE).

You may also find that ISDN rates in your area vary widely with what a branch office is quoted in another part of the country. Service prices vary depending on which ISDN service provider you use and if you are charged a flat rate or your usage is metered. You'll also pay different rates for all-day or off-peak service. Expect baseline costs to run from $20 to about $70 per month for BRI. On top of this, some Regional Bell Operating Companies charge an onerous extra fee just for the privilege of running local data over ISDN. (Some network administrators sarcastically refer to this as the ISDN Data Penalty.)

On the bright side, prices for hardware are going down. Until recently, digital WAN devices were very expensive, costing more than $15,000 per location. But now, stand-alone ISDN bridges, supporting a number of remote

COMPARING ACCESS TECHNOLOGIES

TECHNOLOGY	SPEED	MONTHLY SERVICE COST	PROS	CONS
POTS/V.34 Modem	28.8 Kbps	—[1]	• Worldwide network and proven technology • Ready availability for mobile workers • Relatively low cost for small transmissions	• Slow speed • Poor line quality can slow transmissions
T-1	1.5 Mbps	$16,925[2]	• Well-established technology • Widely available • High bandwidth for full-time connections	• Flat-rate charges mean you pay even when you're not using the connection • Moving or adding connections requires work orders
Switched 56	56 Kbps	$1585[2]	• Relatively fast digital service	• Costs can be uneconomical for low-traffic operations
ISDN (BRI)	128 Kbps	$350[3]	• Fast digital connections can handle data, voice, video • Increasing availability	• Surcharges can be exorbitant • Not available everywhere
Frame Relay	2 Mbps	$25,943[2]	• High bandwidth • Packets can shrink or grow to match file sizes	• Service can be expensive • Connections to LANs require routers
ATM	622 Mbps	$34,650[2]	• High, scalable bandwidth • Can handle data, voice, video	• Products, services not yet readily available

[1] Pricing is too variable to estimate.
[2] Prices based on a star topology network used by main headquarters with five branch offices. Source: TeleChoice Inc.
[3] Estimate for basic connection between a headquarters and five branch offices; does not include transmission costs or surcharges.

workstations, are available for less than $2000. Single-workstation network devices, in the form of stand-alone units, typically sell for less than $750. The price tag for an internal ISDN bus card can be as low as $250. That's comparable to some high-speed modems; however, an ISDN card offers significantly better throughput than even the fastest modem.

ISDN PC cards—from companies such as DiGi International, ISDN*Tek, and others—act like a standard network interface card, which simplifies the network connection to a single RJ-45 cable plugged into the back of the user's computer. Some external and internal devices even contain the network terminator (also known as NT-1) required with ISDN lines. This can save money, and it can also make installation considerably easier.

Along with single-user and multiuser remote devices, there is a crop of multiple-channel ISDN WAN hubs designed for use on the enterprise backbone. Hub devices support a number of remote users through multiple BRI or PRI connections, or a combination of both. Hub units that can serve 160 simultaneous users cost in the $6000 to $12,000 range. These units are ideal for variable-load WAN environments. A hub site ISDN bridge can be configured to filter packets and compress data so that the link performance is optimized (see the table "Typical Configuration of a Hub Site ISDN Bridge" on page 44). These bridges can dial back a user for security purposes, and they can save money by consolidating phone charges and getting a volume discount for calls originating from the central site.

Digital Alternatives

ISDN isn't the only digital game going (see the table "Comparing Access Technologies" on page 44). ATM handles traditional and multimedia data at throughput speeds that scale from 50 Mbps to 622 Mbps. This cell-switched technology breaks up data into neat 53-byte chunks at the sender. Each chunk carries the destination address and is free to choose the path across the WAN that's quickest to the intended receiver. Once all the chunks arrive, the receiver reassembles the data into its original form.

In time, ATM may be the technology that visually links remote sites via videoconferencing. While promising as a WAN technology, the commercial market for ATM remains nascent. In addition, ATM standards, including those that define how the technology will work with current network protocols, are still being developed. ATM should certainly be on your list of strategic technologies for the future, but to get actual work done now, rely on more traditional technologies.

Switched 56, another digital WAN option, can provide dial-up connections with up to 24 simultaneous channels. You'll need to install a CSU/DSU (channel service unit/data service unit) or a special modem, but call connection times are only a couple seconds, and throughput rates max out at 1.5 Mbps.

Frame relay is a packet-switched technology related to X.25. The difference is that frame relay jettisons the error-checking capabilities of X.25 to reduce overhead and achieve speeds of 2 Mbps. Frame-relay packets can be of variable sizes to dynamically handle larger files. To transform traditional LAN packetized data into frame-relay packets, you need to connect a router, bridge, or FRAD (frame-relay access device) to your local network. Pricing for frame-relay service varies depending on the number and the line speeds of the access points you set up on your network. Pricing may be a flat rate or it may be based on usage. Costs may run $500 a month or more.

Don't Dis Modems

Digital technologies may be the flashiest ways of making remote connections, but high prices and availability problems can dull their luster. You may never think of POTS (plain old telephone system) as being flashy, but for ubiquitous service, fast connections for mobile workers, and low costs for modest-size data transfers, it's hard to beat a fast modem (see the figure "How They Work" on page 48).

Today's V.34 modems offer more than top-end modem speed. The standard makes these modems more efficient than their predecessors ever were. For example, V.34 devices can monitor line conditions throughout the duration of a connection, not just in the beginning. This means that a V.34 modem can slow down or speed up to match changes in line quality. Poor quality can lead to an initial connection of

STRANGER DANGER

As more people gain access to the enterprise, the risk to network security increases, and WAN administrators must constantly strike a balance between connectivity and security. No security measure is foolproof, but there are steps you can take to minimize the risks.

As a rule, digital technologies are more secure than analog. Much to the chagrin of some federal agencies, the emergence of digital telecommunications technology has thwarted standard wire-tapping techniques. Recently, the FBI expressed frustration at its inability to tap ISDN circuits.

Given time, there is little doubt that the FBI, and others perhaps less honorable, will develop methods to trap digital data. Meanwhile, corporate data running over digital links remains relatively secure.

ISDN has additional security available through ICLID (Incoming Caller IDentification). With ISDN, call setup messages contain the numbers of the calling and called parties. Network devices can be programmed to check the ICLID and reject connection attempts from unauthorized telephone numbers. LAN administrators must realize that ICLID information only indicates that the correct line is being used—it does not validate the user.

No matter what security measures are inherent in the technology you choose, continue to take more mundane defenses seriously. Passwords are a good first line of defense for keeping unauthorized remote users away from network services. However, password protection should be used only in combination with other security measures.

Authentication, based on Kerberos or internal codes created in WAN devices, is also valuable for WAN security.

Callbacks are another popular form of security for both analog and digital services. The user calls in, is validated, and is disconnected. The network then calls back the validated user. Besides providing security, callbacks can be a helpful tool for billing purposes.

There is also the possibility of unauthorized access through a telecommuter's workstation. The solutions here are much the same as those for the corporate environment. The workstation can be password-protected. Automatic log-ins should be prohibited.

Restricting physical access to the workstation at home is more difficult than in the office, but it can be done.

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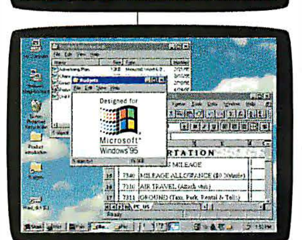
1. First, copy a file from one directory to another. Okay, now copy another file. On average, it takes about eleven steps per file. Now copy a file with Norton Navigator. Mission accomplished. One step.

2. Opening a folder in Windows 95 takes a full five clicks of your trusty mouse. But with Norton Navigator, you can open any folder with just one simple click.

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4. Use Norton Navigator to plug into your Internet connection right from the File Manager. You can be out there using FTP to get files in one third the time it would take you with a separate application.

5. Try a word search for "profits" or any other text string within files. It's at least ten times faster on average with Norton Navigator. No matter how many files you have. Or how big they are. In fact, the bigger the files, the more time you'll save.



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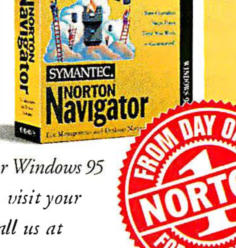


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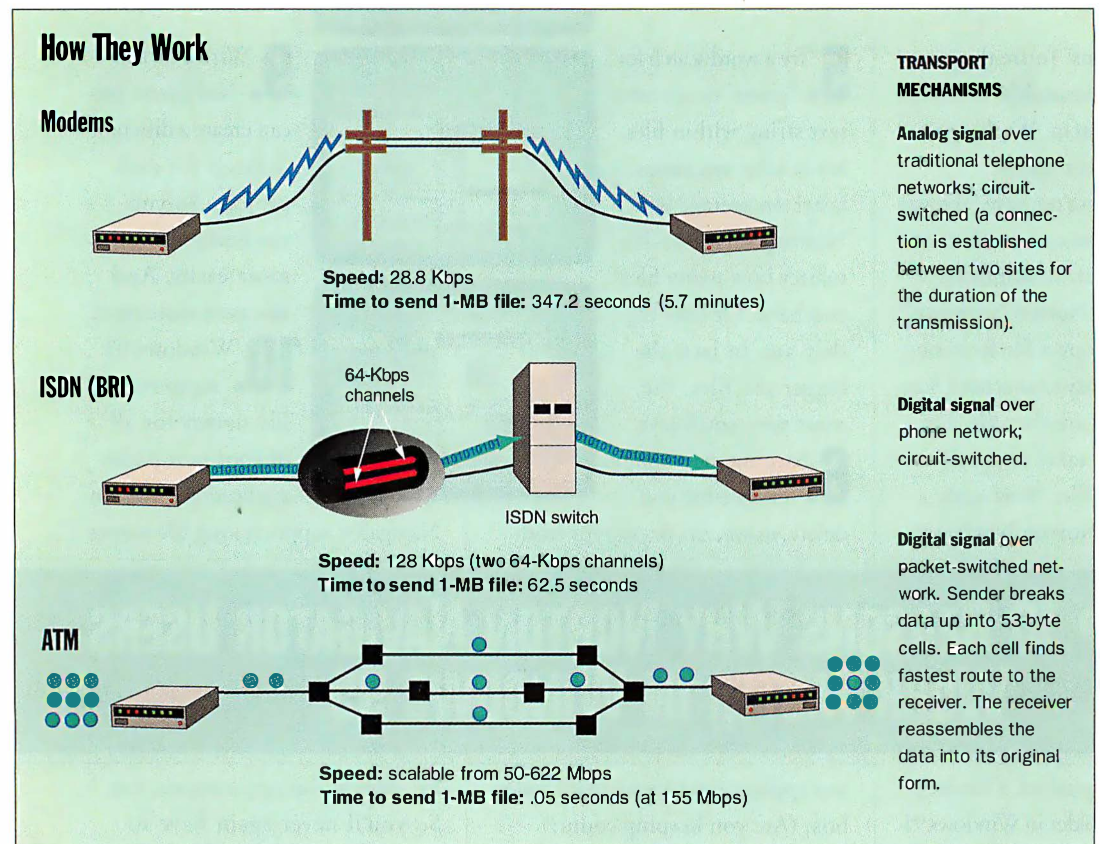
If you own Norton Desktop, PC Tools, XTree, or Norton Commander, get your $39.95 trade-up edition of Norton Navigator for Windows 95 today. To purchase, visit your software store or call us at 1-800-450-9760 ext. 9AP7.*



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less than 28.8 Kbps, but if quality improves during a transmission, a V.34 unit reacts by boosting throughput. Likewise, it can drop back to slower speeds if quality dissolves. Earlier modems connected at slower speeds or even broke the connection.

Using protocols such as SLIP and PPP, modems can give remote users access to local networks. By specifying how data is encapsulated before it traverses a WAN, PPP provides a standard way for modems and servers to communicate, no matter if they're running Windows, Unix, the Mac OS, or OS/2.

In addition to traditional single-user modems, some vendors, such as Microcom and Shiva, offer network modems that have been designed with remote access in mind. For example, Shiva's NetModem/E is a V.34 modem designed for dial-in connections and for connecting LANs. The company's LANRover/2E Plus is a router for remote-access applications; it uses a V.34 modem and ISDN module.

While modems provide an economical way to dial into a LAN, even 28.8 Kbps can seem slow if you're transmitting large files. Modem manufacturers have become adept at incorporating compression algorithms into their products. However, there remains a throughput ceiling above which analog services cannot go.

Nevertheless, modems will simply be the only way to provide enterprise access to a significant number of remote users. Modems are particularly effective if you need a roving link, or if you want to connect remote workers who need only E-mail or who occasionally upload or download files. Modems won't blind you with their speed, but they use time-proven technology and they're readily available.



Where to Find

DiGi International Inc.
Eden Prairie, MN
(612) 943-9020
fax: (612) 943-5398

ISDN*Tek
San Gregorio, CA
(415) 712-3000

Microcom Inc.
Norwood, MA
(617) 551-1000
fax: (617) 551-1021

Shiva Corp.
Burlington, MA
(508) 788-3061
fax: (508) 788-1539

Take the Long View

As you're evaluating technologies to make your current WAN environment efficient and cost-effective, don't neglect to plan for the future. WAN connections tend to grow exponentially over time as more and more users require enterprise-wide services. As the WAN grows, the job of network management can become complex and time-consuming.

Network operators can minimize management overhead through WAN devices that support SNMP, Telnet, and TFTP (Trivial File Transfer Protocol). These tools allow network technicians to administer and upgrade devices without traveling to the remote site. Using SNMP or Telnet, network managers can monitor and configure remote devices from the network control center. Similarly, TFTP allows managers to install software upgrades over the network. These tools help immensely when the remote device is hundreds of miles away from the enterprise network.

Also keep in mind that bandwidth does not buy you everything. Adequate bandwidth will help remote users feel comfortable accessing their corporate network. However, access does not necessarily translate into efficient or functional usage. Don't confuse wide-area *networks* with wide-area *services.*

For a variety of reasons, WAN users might have restricted access to enterprise services. Certain file servers and printers might be unavailable to WAN users for security reasons. Remote users might have access to TCP/IP-based services, but not to NetWare or AppleTalk. Restricted services can be a cost, security, or bandwidth-conservation issue. Remote users need to understand that they will not necessarily have all the services they might be used to.

Ad hoc WANs are no longer considered some kind of far-out future computing environment. Telecommuting and remote office connections to enterprise networks are a growing reality in business today. It takes extra resources, planning, and thoughtful deployment to provide secure and efficient WAN services. However, the benefits in getting beyond the LAN outweigh the costs. ■

Jeffrey Fritz is a telecommunications engineer who designs and manages data communications for West Virginia University, including its ISDN applications lab. Fritz chairs the National Information Infrastructure Working Group. You can contact him on the Internet at jfritz@wvnvm.wvnet.edu or on BIX c/o editors.



ANNIVERSARY EDITION



20 YEARS

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Operating *Environments*

PC: DOS, Windows, Windows NT, Win32s, Windows 95, OS/2, SCO Unix, SCO Xenix, Interactive Unix, AIX, AutoCAD, DOS Extenders, LANs
MAC: Mac, Power Mac, LANs (ADB port)
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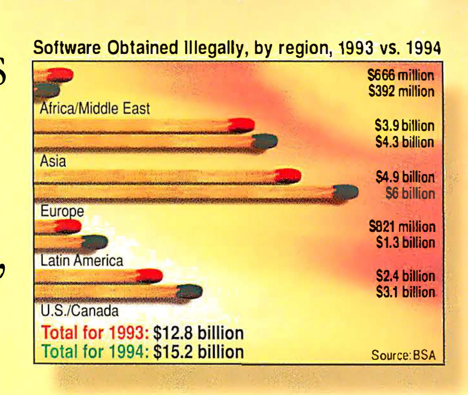
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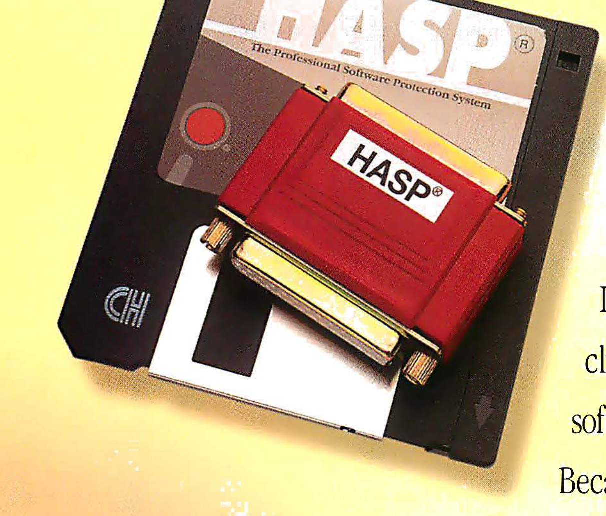
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Software Developers:

Software Piracy Burns Your Profits

BYTE 20TH ANNIVERSARY REPORT

Message from the Editor in Chief

This special report marks the culmination of BYTE's twentieth year of publishing. Our magazine has changed a lot in 20 years. So has the microcomputer industry. And so has the BYTE reader.

Twenty years ago, a devoted cadre of hobbyists and home-brew computer engineers made up the readership of this magazine. We built computers with our bare hands and toggled programs via front-panel switches. A mouse was a rodent, a network was a collection of business acquaintances, and gooey and scuzzy were undesirable attributes of decaying vegetation.

Now we're hurtling toward a future where computers are integral to all strata of business and society. In the pages of BYTE each month, we celebrate and explain our advancing technologies. We look to give you the information you need to plan for tomorrow.

While no other group is as resolutely focused on the future as are technologists, it's valuable to look back at the people and achievements that have put us where we are now. Today's technology has evolved from the creative imagination of a core group of visionaries, realized in their companies, their products, and their successes and failures.

This special report is a nostalgia trip; it puts us in the crotchety-old-man role of saying, "Yep, Sonny, I remember when 64 KB was all the memory we'd ever need." Of course, 20 years from now, we'll be peering into history yet again, laughing at the previous generation's lack of horsepower, bandwidth, and integration—and, probably, once again remembering the "old days" with a peculiar fondness.

Raphael Needleman, Editor in Chief



AS A REWARD FOR HARD WORK, WE LET THE TWENTIETH ANNIVERSARY EDITORIAL CREW OUT OF THE BUILDING. BUT ONLY FOR A MOMENT.

CONTENTS

1

BYTE 20TH ANNIVERSARY REPORT

Top 20 Small Syst

From soldering irons to SparcStations, from MITS to Macintosh, personal computers have evolved from do-it-yourself kits for electronics hobbyists into machines that practically leap out of the box and set themselves up. What enabled them to get from there to here? Innovation and determination. Here are the top 20 systems that made that rapid evolution possible.

■ MITS Altair 8800

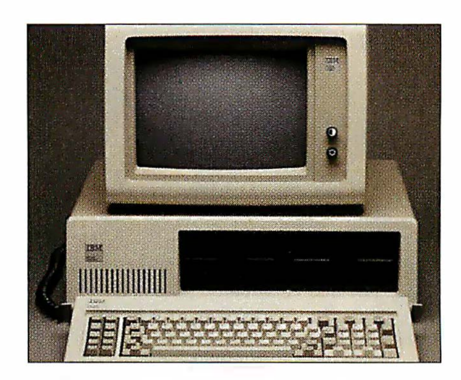
There once was a time that you could buy a top-of-the-line computer for $395. The only catch was that you had to build it yourself. Although the Altair 8800 wasn't actually the first personal computer (Scelbi Computer Consulting's 8008-based Scelbi-8H kit probably took that honor in 1973), it grabbed attention. MITS sold 2000 of them in 1975—more than any single computer before it.

Based on Intel's 8-bit 8080 processor, the Altair 8800 kit included 256 bytes of memory (upgradable, of course) and a toggle-switch-and-LED front panel. For amenities such as keyboards, video terminals, and storage devices, you had to go to one of the companies that sprang up to support the Altair with expansion cards. In 1975, MITS offered 4- and 8-KB Altair versions of BASIC, the first product developed by Bill Gates' and Paul Allen's new company, Microsoft.

If the personal computer hobbyist movement was simmering, 1975 saw it come to a boil with the introduction of the Altair 8800.



"ANYBODY WHO COULD WRITE A GOOD APPLICATION ON THE 128K MAC DESERVES A MEDAL."–BILL GATES



THE STORY GOES THAT THE CHAIRMAN OF IBM LOOKED AT THE ORIGINAL PC AND SAID THAT IT WOULD NEVER FLY–THAT MAINFRAMES WOULD DOMINATE FOREVER. TELL ME AGAIN WHY PEOPLE WERE BUYING STOCK IN THIS COMPANY.

■ Apple II

Those of you who think of the IBM PC as the quintessential business computer may be in for a surprise: The Apple II (together with VisiCalc) was what really made people look at personal computers as business tools, not just toys.

The Apple II debuted at the first West Coast Computer Faire in San Francisco in 1977. With built-in keyboard, graphics display, eight readily accessible expansion slots, and BASIC built into ROM, the Apple II was actually easy to use. Some of its innovations, like built-in high-resolution color graphics and a high-level language with graphics commands, are still extraordinary features in desktop machines.

With a 6502 CPU, 16 KB of RAM, a 16-KB ROM, a cassette interface that never really worked well (most Apple IIs ended up with the floppy drive that was announced in 1978), and color graphics, the Apple II sold for $1298.

■ Commodore PET

Also introduced at the first West Coast Computer Faire, Commodore's PET (Personal Electronic Transactor) started a long line of inexpensive personal computers that brought computers to the masses. (The VIC-20 that followed was the first computer to sell 1 million units, and the Commodore 64 after that was the first to offer a whopping 64 KB of memory.)

The keyboard and small monochrome display both fit in the same one-piece unit. Like the Apple II, the PET ran on MOS Technology's 6502. Its $795 price, key to the PET's popularity, supplied only 4 KB of RAM but included a built-in cassette tape drive for data storage and an 8-KB version of Microsoft BASIC in its 14-KB ROM.

■ Radio Shack TRS-80

Remember the Trash 80? Sold at local Radio Shack stores in your choice of color



ems

(Mercedes Silver), the TRS-80 was the first ready-to-go computer to use Zilog's Z80 processor.

The base unit was essentially a thick keyboard with 4 KB of RAM and 4 KB of ROM (which included BASIC). An optional expansion box that connected by ribbon cable allowed for memory expansion. A Pink Pearl eraser was standard equipment to keep those ribbon cable connections clean.

Much of the first software for this system was distributed on audiocassettes played in from Radio Shack cassette recorders.

■ Osborne 1 Portable

By the end of the 1970s, garage start-ups were passé. Fortunately there were other entrepreneurial possibilities. Take Adam Osborne, for example. He sold Osborne Books to McGraw-Hill and started Osborne Computer. Its first product, the 24-pound Osborne 1 Portable, boasted a low price of $1795.

More important, Osborne established the practice of bundling software—in spades. The Osborne 1 came with nearly $1500 worth of programs: WordStar, SuperCalc, BASIC, and a slew of CP/M utilities.

Business was looking good until Osborne preannounced its next version while sitting on a warehouse full of Osborne 1s. Oops. Reorganization under Chapter 11 followed soon thereafter.

■ Xerox Star

This is the system that launched a thousand innovations in 1981. The work of some of the best people at Xerox PARC (Palo Alto Research Center) went into it. Several of these—the mouse and a desktop GUI with icons—showed up two years later in Apple's Lisa and Macintosh computers.

The Star wasn't what you'd call a commercial success, however. The main problem seemed to be how much it cost. It would be nice to believe that someone shifted a decimal point somewhere: The pricing started at $50,000.

■ IBM PC

Irony of ironies that someone at mainframe-centric IBM recognized the business potential in personal computers. The result was the 1981 landmark announcement of the IBM PC. Thanks to an open architecture, IBM's clout, and Lotus 1-2-3 (announced one year later), the PC and its progeny made business micros legitimate and transformed the personal computer world.

The PC used Intel's 16-bit 8088, and for $3000, it came with 64 KB of RAM and a 5¼-inch floppy drive. The printer adapter and monochrome monitor were extras, as was the color graphics adapter.

■ Compaq Portable

Compaq's Portable almost single-handedly created the PC clone market. Although that was about all you could do with it single-handedly—it weighed a ton. Columbia Data Products just preceded Compaq that year with the first true IBM PC clone but didn't survive. It was Compaq's quickly gained reputation for engineering and quality, and its essentially 100 percent IBM compatibility (reverse-engineered, of course), that legitimized the clone market. But was it really designed on a napkin?

■ Radio Shack TRS-80 Model 100

Years before PC-compatible subnotebook computers, Radio Shack came out with a book-size portable with a combination of features, battery life, weight, and price that

Five Peripherals the PC Revolution Couldn't Do Without

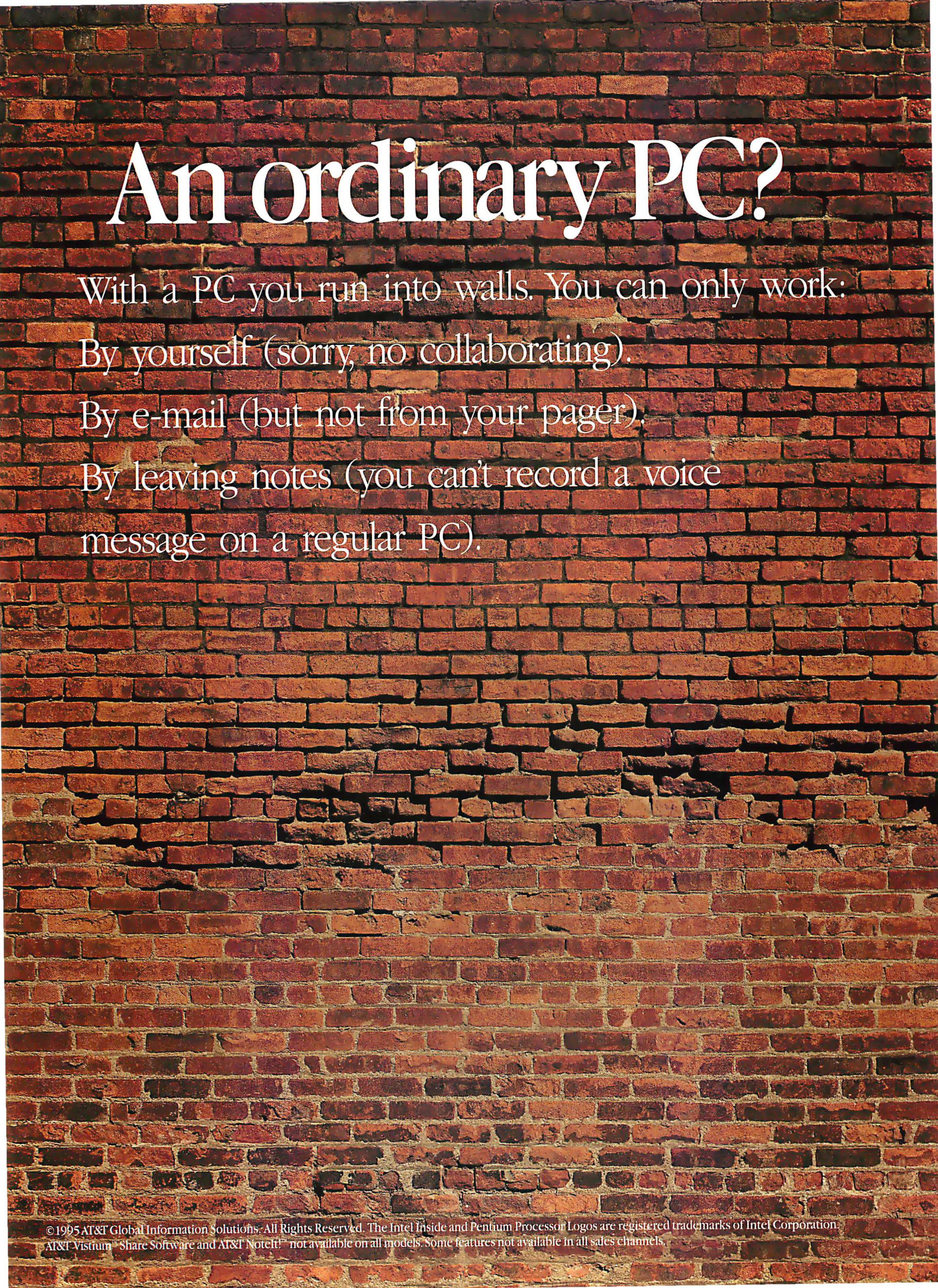
1) SHUGART 5¼-INCH FLOPPY DRIVE
Before PC hard drives were available, the floppy drive was the "mass" storage medium of choice. It killed paper tapes and audiocassettes.

2) EPSON MX-80
Fast and inexpensive, and it could also do graphics (with a later upgrade). What good is a spreadsheet chart if you can't print it out? The competing daisy wheel's advantage was typewriter text clarity.

3) SEAGATE 5¼-INCH 5-MB WINCHESTER HARD DRIVE
Now this was mass storage that could fit in a PC—once the price came down. Alan Shugart was involved here, too.

4) HAYES SMARTMODEM 300
The modem that launched the industry-standard AT command set.

5) HEWLETT-PACKARD LASERJET
Graphics, speed, and sharp text for less than $2000, thanks to Canon's 300-dpi laser engine. Using the same engine, Apple came out with its LaserWriter shortly thereafter.


An ordinary PC?
With a PC you run into walls. You can only work:
By yourself (sorry, no collaborating).
By e-mail (but not from your pager).
By leaving notes (you can't record a voice message on a regular PC).
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Top 20 Small Systems

is still unbeatable. (Of course, the Z80-based Model 100 didn't have to run Windows.)

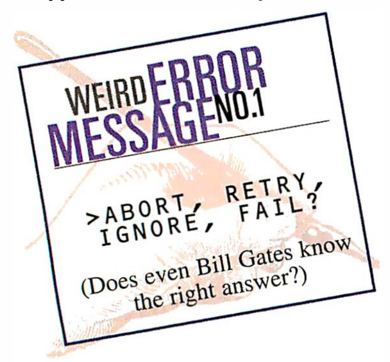
The $800 Model 100 had only an 8-row by 40-column reflective LCD (large at the time) but supplied ROM-based applications (including text editor, communications program, and BASIC interpreter), a built-in modem, I/O ports, nonvolatile RAM, and a great keyboard. Weighing under 4 pounds, and with a battery life measured in weeks (on four AA batteries), the Model 100 quickly became the first popular laptop, especially among journalists.

With its battery-backed RAM, the Model 100 was always in standby mode, ready to take notes, write a report, or go on-line. NEC's PC 8201 was essentially the same Kyocera-manufactured system.

■ Apple Macintosh

Whether you saw it as a seductive invitation to personal computing or a cop-out to wimps who were afraid of a command line, Apple's Macintosh and its GUI generated even more excitement than the IBM PC. Apple's R&D people were inspired by critical ideas from Xerox PARC (and practiced on Apple's Lisa) but added many of their own ideas to create a polished product that changed the way people use computers.

The original Macintosh used Motorola's 16-bit 68000 microprocessor. At $2495, the system offered a built-in high-resolution monochrome display, the Mac OS, and a single-button mouse. With only 128 KB of RAM, the Mac was underpowered at first. But Apple included some key applications that made the Macintosh immediately useful. (It was MacPaint that finally showed people what a mouse is good for.)



■ IBM AT

George Orwell didn't foresee the AT in 1984. Maybe it was because Big Blue, not Big Brother, was playing its cards close to its chest. The IBM AT set new standards for performance and storage capacity. Intel's blazingly fast 286 CPU running at 6 MHz and a 16-bit bus structure gave the AT several times the performance of previous IBM systems. Hard drive capacity doubled from 10 MB to 20 MB (41 MB if you installed two drives—just don't ask how they did the math), and the cost per megabyte dropped dramatically.

New 16-bit expansion slots meant new (and faster) expansion cards but maintained downward compatibility with old 8-bit cards. These hardware changes and new high-density 1.2-MB floppy drives meant a new version of PC-DOS (the dreaded 3.0).

The price for an AT with 512 KB of RAM, a serial/parallel adapter, a high-density floppy drive, and a 20-MB hard drive was well over $5000—but much less than what the pundits expected.

■ Commodore Amiga 1000

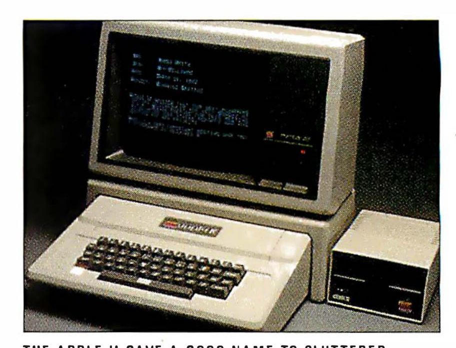
The Amiga introduced the world to multimedia. Although it cost only $1200, the 68000-based Amiga 1000 did graphics, sound, and video well enough that many broadcast professionals adopted it for special effects. Its sophisticated multimedia hardware design was complex for a personal computer, as was its multitasking, windowing OS.

■ Compaq Deskpro 386

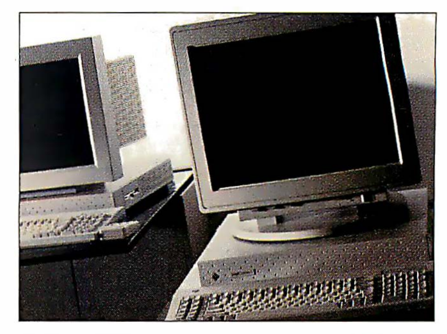
While IBM was busy developing (would "wasting time on" be a better phrase?) proprietary Micro Channel PS/2 systems, clone vendors ALR and Compaq wrested away control of the x86 architecture and



HELLO? TECHNICAL SUPPORT? I THINK I MISPLACED THE MONITOR FOR MY OSBORNE PORTABLE. IT DOES HAVE A MONITOR, DOESN'T IT? OH, THAT'S THE MONITOR.



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Circle 241 on Inquiry Card (RESELLERS: 242).



Top 20 Small Systems

introduced the first 386-based systems, the Access 386 and the Deskpro 386. Both systems maintained backward compatibility with the 286-based AT.

Compaq's Deskpro 386 had a further performance innovation in its Flex bus architecture. Compaq split the x86 external bus into two separate buses: a high-speed local bus to support memory chips fast enough for the 16-MHz 386, and a slower I/O bus that supported existing expansion cards.

■ Apple Macintosh II

When you first looked at the Macintosh II, you may have said, "But it looks just like a PC." You'd have been right. Apple decided it was wiser to give users a case they could open so they could upgrade it themselves. The monitor in this 68020-powered machine was a separate unit that typically sat on top of the CPU case.

■ Next Nextstation

Unix had never been this easy to use, and only now, 10 years later, are we getting back to that level. Unfortunately, Steve Jobs' cube never developed the software base it needed for long-term survival. Nonetheless, it served as an inspiration for future workstations.

Priced at less than $10,000, the elegant Nextstation came with a 25-MHz 68030 CPU, a 68882 FPU, 8 MB of RAM, and the first commercial magneto-optical drive (256-MB capacity). It also had a built-in DSP (digital signal processor). The programming language was object-oriented C, and the OS was a version of Unix, sugarcoated with a consistent GUI that rivaled Apple's.

■ NEC UltraLite

NEC's UltraLite is the portable that put *subnotebook* into the lexicon. Like Radio Shack's TRS-80 Model 100, the UltraLite was a 4-pounder ahead of its time. Unlike the Model 100, it was expensive (starting price, $2999), but it could run MS-DOS. (The burden of running Windows wasn't yet thrust upon its shoulders.)

Fans liked the 4.4-pound UltraLite for its trim size and portability, but it really needed one of today's tiny hard drives. It used battery-backed DRAM (1 MB, expandable to 2 MB) for storage, with ROM-based Traveling Software's LapLink to move stored data to a desktop PC.

Foreshadowing PCMCIA, the UltraLite had a socket that accepted credit-card-size ROM cards holding popular applications like WordPerfect or Lotus 1-2-3, or a battery-backed 256-KB RAM card.

■ Sun SparcStation 1

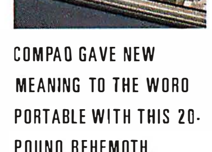
It wasn't the first RISC workstation, nor even the first Sun system to use Sun's new SPARC chip. But the SparcStation 1 set a new standard for price/performance, churning out 12.5 MIPS at a starting price of only $8995—about what you might spend for a fully configured Macintosh. Sun sold lots of systems and made the words *Sparc-Station* and *workstation* synonymous in many people's minds.

The SparcStation 1 also introduced S-Bus, Sun's proprietary 32-bit synchronous bus, which ran at the same 20-MHz speed as the CPU.

■ IBM RS/6000

Sometimes, when IBM decides to do something, it does it right. (Other times... Well, remember the PC jr.?) The RS/6000 allowed IBM to enter the workstation market. The RS/6000's RISC processor chip set (RIOS) racked up speed records and introduced many to the term *superscalar*. But its price was more than competitive. IBM pushed third-party software support, and as a result, many desktop publishing, CAD, and scientific applications ported to the RS/6000, running under AIX, IBM's Unix.

A shrunken version of the multichip RS/6000 architecture serves as the basis for the single-chip PowerPC, the non-x86-compatible processor with the best chance of competing with Intel.



COMPAQ GAVE NEW MEANING TO THE WORD PORTABLE WITH THIS 20-POUND BEHEMOTH.



A 4-POUND BUNDLE OF JOY: THE TRS-80 100.



ELEVEN YEARS LATER: STILL LIVING WITH THE AT ARCHITECTURE.



PET PEEVE? SOMEONE TOOK A DESKTOP CALCULATOR AND FED IT STEROIDS FOR A YEAR TO SEE WHAT HAPPENS.

■ Apple Power Macintosh

Not many companies have made the transition from CISC to RISC this well. The Power Macintosh represents Apple's well-planned and successful leap to bridge two disparate hardware platforms. Older Macs run Motorola's 680x0 CISC line, which is running out of steam; the Power Macs run the PowerPC RISC chip. The new Macs run existing 680x0-based applications yet provide PowerPC performance, a combination that sold over a million systems in a year.

■ IBM ThinkPad 701C

It's not often anymore that a new computer inspires gee-whiz sentiment, but IBM's Butterfly subnotebook does, with its marvelous expanding keyboard. The 701C's two-part keyboard solves the last major piece in the puzzle of building a usable subnotebook: how to provide comfortable touch-typing. (OK, so the floppy drive is still external.)

With a full-size keyboard and a 10.4-inch screen, the 4.5-pound 701C compares favorably with full-size notebooks. Battery life is good, too.



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BYTE 20TH ANNIVERSARY REPORT

2 MOST IMPORTANT Software Prod

The 20-year story of personal computing often seems to be dominated by hardware. But it's the software that makes the hardware worth owning: Many early buyers of Apple IIs walked into stores and asked for the VisiCalc machine.

■ CP/M 2.0

Developed by the late Gary Kildall in 1974, CP/M was the first OS to run on machines from different vendors. It became the preferred OS for most software development, and it looked like it would rule forever.

■ VisiCalc

Written in 1979 by first-year Harvard Business School student Dan Bricklin and Bob Frankston of MIT, VisiCalc was a godsend to Wall Street users who had bought the first microcomputers two years earlier. Running initially on the Apple II and nearly single-handedly creating the demand for the machine, VisiCalc established spreadsheets as a staple application, setting the stage for Lotus 1-2-3 on the IBM PC in 1982.

■ WordStar

While writing programs on the Altair, Michael Shrayer hit upon the idea of writing the manuals on the same machine. Electric Pencil was born, the first microcomputer word processor. But the first program to exploit the market potential was Seymour Rubinstein's 1979 masterpiece, WordStar. Other programs took up WordStar-compatible keyboard commands—including the last major upgrade of Electric Pencil.

■ dBase II

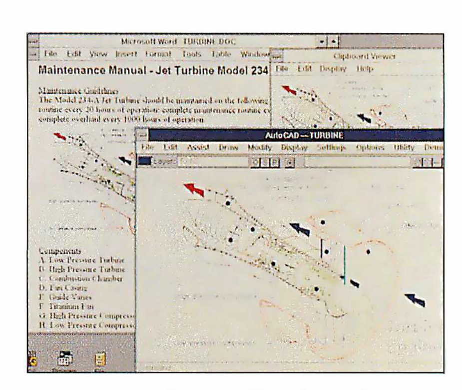
Wayne Ratliff's creation, first intended to manage a company football pool, was the first serious database management system for CP/M. dBase II, in its DOS incarnation, was a massive success. Ashton-Tate, which acquired dBase from Ratliff, began to lose the lead when it released the bug-ridden dBase IV in 1988. A Windows version (under the ownership of Borland) didn't appear until 1994, much too late. The dBase language survives in the form of Xbase, supported by vendors such as Microsoft and Computer Associates.

■ AutoCAD

Autodesk's AutoCAD started life as a CP/M (Control Program for Microcomputers) application, later moved to DOS, and eventually made the transition to Windows. It brought CAD from minis and mainframes down to the desktop, one of the first programs to make that now-common migration. AutoCAD quickly became—and remains—an industry standard.

■ Lotus 1-2-3

VisiCalc may have sold Wall Street on the idea of electronic spreadsheets, but 1-2-3 was the spreadsheet that Main Street wanted, too. When the IBM PC and XT took over the world, Lotus's simple but elegant grid was without question the top spreadsheet to run on them, adding graphics and data-retrieval functions to the paradigm established by VisiCalc. By the early 1990s, Lotus could brag that 1-2-3 was the top-selling application of all time.

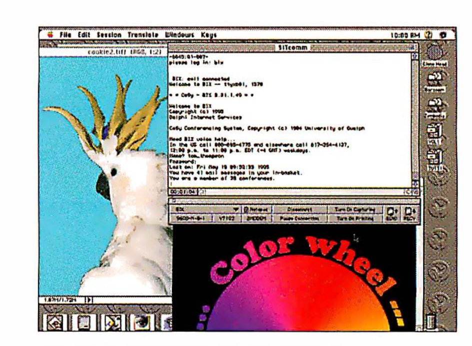


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4	Clothing	120	120
5	Savings	177	177
6			
7	Leisure	223	223
8	Sav Acct	0	
9	Car Insur	160	
10	Interest	.42	.49
11	100	117.08	294.24
12			
13	Mortgage	.33	.33
14	Utilities	.08	.08
15	Telephone	.04	.04

QUITE POSSIBLY THE PROGRAM RESPONSIBLE FOR THE '80'S WALLSTREET FRENZY: VISICALC ON THE APPLE II.



APPLE'S MACINTOSH OS HAD THE FIRST REAL GRAPHICAL USER INTERFACE AND AWESOME EASE OF USE. TOO BAD WINDOWS DIDN'T COPY MORE OF IT.



ucts

■ **The Norton Utilities**
Before Peter Norton rolled up his sleeves, bit twiddlers were on their own when it came to recovering lost clusters and managing other disk catastrophes. It's almost the end of the millennium, and most of us still reach for Norton Utilities when something goes wrong with a disk.

■ **DOS 2.0**
The version of DOS that truly solidified the Microsoft/IBM platform dominance was 2.0, which came out with IBM's new XT in 1983. DOS 2.0 had commands to support the XT's new 10-MB hard drive as well as such now-familiar external commands and files as ANSI.SYS and CONFIG.SYS.

DOS 2.11 became the de facto basis of backward compatibility for any DOS program. In 1990, you might not have known if an application ran on DOS 5.0, but you could be sure it worked on old 2.11. DOS limitations even survive in Windows 95—in particular, the dreaded 640-KB memory limit.

■ **Flight Simulator**
To work its magic, Microsoft's simulation of an airplane's cockpit employed low-level graphics routines. It became a mainstay of software suites used to test compatibility with the IBM PC standard. It was also one of the best-selling games of all time.

■ **Novell NetWare**
The year of the LAN happened sometime in the 1980s, and it was Novell's NetWare that made it so. NetWare is no lightweight desktop OS. NetWare was an OS that systems administrators could rely on. Versions of this OS are still in use in businesses everywhere.

■ **Unix System V**
The best effort so far at unifying the diverse flavors of Unix, System V took off after AT&T's divestiture in 1984, when Ma Bell was freed to market the OS more aggressively. Version 4.0, released in 1989, brought together Xenix, SunOS, 4.3 BSD, and System V to form a single standard. Hardware vendors continued to go their own ways, however, requiring subsequent efforts by numerous groups (e.g., X/Oepen, OSF, and COSE) to continue the fight for a shrink-wrappable Unix. Those efforts have mostly failed, but Unix's communications standards and network protocols are finding a wider user base as the Internet explodes in popularity.

■ **Mac OS and System 7**
The Macintosh wouldn't be the Macintosh without the Mac OS. And it was on the Macintosh that the concept of the desktop GUI really dug in. Later named System 7 in a major 1990 upgrade, the Mac continues to best Windows in ease of use, plug-and-play compatibility, and color matching. Apple's Power Macs and the first Mac clones just might keep System 7 relevant into the next century.

■ **Quicken**
This checkbook-balancing program may be better-suited to the needs of its users than any other program on this list save VisiCalc. Scott Cook's company grew from humble beginnings in the mid-1980s to become Microsoft's multibillion dollar dance partner (until the Department of Justice cut in). Once you start balancing your checkbook in Quicken, you don't ever go back.

17 YEARS AGO IN BYTE



Editor in chief Carl Helmers editorialized about "... Using a Personal Computer for a Practical Purpose."

President Carter signs bill intended to reduce unemployment and inflation to 4 percent and 3 percent, respectively.

CP/M Lives

CP/M provides the personal computer industry with its most enduring piece of folklore. When IBM began hunting around for an OS for its planned PC, it sent representatives to Gary Kildall's California office. Kildall was out flying his plane at the time and apparently thought communing with the big blue sky was more important than Big Blue. (Kildall later revealed that other talks with IBM had been inconclusive.) This was possibly the worst display of business acumen since New Hampshire's McDonald brothers sold most of their little hamburger-joint concept to a guy named Ray.

IBM quickly worked out a deal with a young fellow named Bill Gates. Ironically, 86-DOS, the OS that Microsoft bought and turned into MS-DOS 1.0, employed such CP/M commands as REN, Dir, and Type, which are still in use today.

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ViewSonic *17PS*



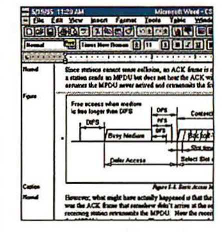


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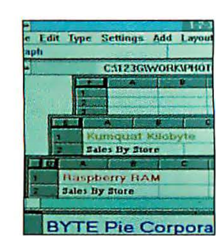


IF THIS IS THE FUTURE OF GAMES, WE'RE DOOMED.

EXCEL, BUILT ON MISTAKES OF OTHERS (SEE BELOW).



WORD 6.0: ACCORDING TO SOME, THE BEST APPLICATION EVER WRITTEN.



LOTUS HAD IT BUT LOST IT. A GOOD WINDOWS SPREADSHEET, BUT TOO LATE.

Tomorrow's Top Five Software Categories

Which programs will be the VisiCalcs and WordStars of the next five years? We've seen the future...

1) COLLABORATION SOFTWARE

Lotus Notes is proving the value of shared text bases, and E-mail-based alternatives like Collabra Share and Open Mind are also bringing the benefits of group conferencing to new users. As smart agents, natural-language processing, and perhaps expert systems are brought to bear on electronic collaboration, PC-based interaction may begin to rival TV in its impact on society.

2) TEXT SEARCH AND RETRIEVAL

Finding the kernels of information embedded in the chaos of data is a problem that's only going to get bigger, as knowledge bases on CD-ROM and networks continue to grow. The basic pattern matching and Boolean slicing now in place will continue to do most of the work. But look for AI techniques and software agents to find needles in electronic haystacks as well as to present and store the results in a more personalized—and personable—form.

3) OBJECT OPERATING SYSTEMS

So far, the revolution in OOP (object-oriented programming) has been mostly fought in languages and developer tools. The next step is to build an entire OS from objects. There already is such a system, NextStep, Steve Jobs' critically acclaimed box-office flop. Taligent plans to release its entrant sometime in 1996. Even NextStep, long lauded for its elegance but used by only a small fraction of developers, might impact the Windows/PC world when a Windows version comes out next year. Object-based operating environments will facilitate other important technologies, such as modular applications, agents, and distributed computing.

4) MULTIMEDIA DATABASES

No, we're not talking about the desktop file managers that help you pull together 5-second videos for a presentation. This new category is about the huge databases from Oracle, Sybase, and others that will power the coming convergence of computers and the entertainment business. Multimedia databases will be needed to manage the huge libraries of films delivered to homes via cable, as well as to process viewer input as consumers order from on-line catalogs or vote on the endings of soap operas.

5) AGENTS AND AVATARS

The promise of software agents is that they will begin to handle people problems, not just under-the-hood technical chores. General Magic's Magic Cap PDA (personal digital assistant) language is a good example, while the E-mail sorters and sifters that were first introduced years ago are becoming de rigueur in E-mail and other collaboration software. When all the world becomes a database, we'll need agents to keep from drowning.

■ SideKick 1.0

Besides being the first PIM (personal information manager), its pop-up notepad, calendar, and calculator made Borland International's SideKick the model for TSRs—an application type that was relatively rare in 1984. Pop-up mini-apps became commonplace in the DOS era, but Windows' task switching killed the TSR market in the 1990s.

■ Excel for the Macintosh

VisiCalc and Lotus 1-2-3 started the spreadsheet revolution, but they were character-based. Microsoft Excel for the Macintosh made the benefits of graphical spreadsheets obvious. Microsoft ported Excel to Windows, but Lotus was slow to convert 1-2-3 to Windows. There's a lesson here: Today, Excel for Windows is the best-selling spreadsheet.

■ PageMaker

This is the program that launched a million newsletters. PageMaker's paste-up metaphor also made sense to people who had worked in traditional design and production departments. QuarkXPress might now have a larger share in higher-end publishing, but with Adobe's money and name behind Aldus, PageMaker promises to remain a com-



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petitive desktop publishing system for a long time to come.

■ LANtastic

For people who thought Novell NetWare was for corporate MIS gurus, Artisoft's affordable network-card-and-software package was an easy and popular way to link PCs and share resources. With the addition of NetWare server functions in Artisoft's new LANtastic Dedicated Server, LANtastic keeps a foothold in the future.

■ Adobe Type

Desktop publishing was still a bit of a toy when Adobe made Type 1 PostScript fonts available on the Macintosh. Thanks to these fonts and the enhanced line spacing and printing control that PostScript provides, the Mac became a tool on which to run a publishing business.

■ Windows 3.x

Though it was first introduced in 1985, Microsoft Windows spent the rest of the '80s as somewhat of a joke. It was slow, ugly, and underpowered. Then Microsoft rolled out Windows 3.0, a complete rewrite, at a tightly orchestrated, bicoastal multimedia hypefest in the spring of 1990. Gone was the 640-KB DOS memory limit (sort of); in came a flood of applications, a type of multitasking, and the desktop environment most users live in today. Version 3.1, released in 1992, added speed and stability, not to mention OLE, True Type fonts, and drag-and-drop commands.

■ Lotus Notes 3.0

Notes is the most innovative and powerful of the numerous contenders in the leading-edge groupware category. Not just E-mail, Notes is brilliant at capturing corporate group-think, thanks to its unique, replicated message system. Notes has become the standard applications development environment in every company that's ever uttered the word *reengineering*.

The 10 Most Important Programs of Today

The best expressions of software evolution are available in shrink-wrap at your local Egghead.

1) EXCEL 5.0 FOR WINDOWS

In 1990, Excel was more of a Mac than a Windows spreadsheet. But then Lotus delayed bringing 1-2-3 to Windows. By 1993, most users had switched to Windows, and Excel had come to be regarded as the best Windows spreadsheet.

2) MAC SYSTEM 7

Still the best GUI with a wide following, System 7.5 is partially RISC-based—and thus in position to exploit the Power Mac—while still able to run old binaries.

3) MICROSOFT ACCESS 2.0

Though buggy and press-battered in its debut version, Access quickly established itself with a major upgrade as one of the easiest-to-use Windows databases. While Borland has struggled to keep Paradox and once-mighty dBase relevant, Access has easily outsold both.

4) NOVELL NETWARE 4.1

Looking like it might go the way of dBase and 1-2-3 thanks to a disappointing upgrade (4.0), NetWare is back on track with 4.1. Still, the masses are restless, and pretenders like Windows NT are maneuvering into position.

5) LOTUS NOTES

Notes has become an industry. No, it's a way of life. Still way out ahead technically, Notes has maybe a year or two to solidify its position against an onslaught of workgroup programs like Collabra Share.

6) WINDOWS NT

Clearly, this is the future of Windows. If Windows 95 falters at the start, Microsoft has a completely redesigned, true 32-bit OS waiting in the wings. NT will even have the new Windows 95 look and feel.

7) WINDOWS 3.11

As we write this, Windows 95 still isn't out, so Windows 3.11 is the version that sits on most of the 50-million-plus Windows desktops. People love it; people hate it. But they use it.

8) WORD 6.0 FOR WINDOWS

It's big, slow, and overloaded with features. Still, Word 6.0 somehow manages to be the right tool for the simplest to the most complex text jobs. Some people regard it as the best application written.

9) WORDPERFECT

WordPerfect still sells lots of copies of the DOS version, and as the cornerstone for PerfectOffice, the suite from Novell, WordPerfect has a new lease on life. It continues to be the daily work environment of millions.

10) DOOM

Its motion-sickness-inducing virtual reality and large, cult-like following make this gory game from id Software the inspirational example for programmers of action software.

PLUS: MICROSOFT OFFICE

Not a real program but rather a collection of Microsoft's market-dominating applications, Microsoft Office has transcended the dreaded "suite" designation to become the framework for which today's developers are writing new apps.



YOU'LL GET SERVICE WITH MOST PCs. THE QUESTION IS, HOW MUCH?
GUARANTEED AT-YOUR-DESK NEXT-BUSINESS-DAY
NEXT D AY...OR MAYBE THE DAY AFTER
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YOU CAN'T FIGURE IT OUT YOU RSELF?
THE PAR TS ARE IN THE MAIL
GOT A VOL TMETER?

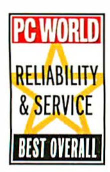
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At Dell, we guarantee* if there's a problem with your Dell Dimension PC, a certified technician will be at your desk the next business day, servicing your PC.^Δ^

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JUNE 1995

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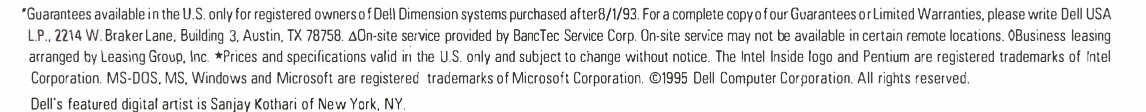
DELL DIMENSION P75
75MHz PENTIUM PROCESSOR

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Dell's featured digital artist is Sanjay Kothari of New York, NY.





All the chips on this list, obscure as some are, had a significant influence on the evolution of personal computing. So what does it take to make a computer today? Mostly, it seems, acronyms: a CPU, some RAM, a handful of EPROMs, a DSP, and a PCI bus.

■ Intel 1103

In 1970, Intel created the 1103—the first generally available DRAM chip. By 1972, it was the best-selling semiconductor memory chip in the world. Today, you would need more than 65,000 of them to put 8 MB of memory into a PC.

■ Intel 1702

In another brilliant stroke of naming, Intel created this, the first EPROM, in 1971. When you say "firmware," smile and think of the 1702.

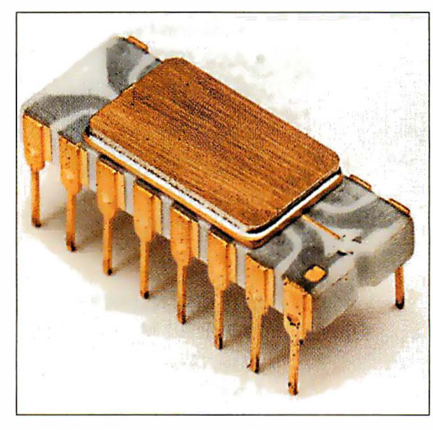
■ Intel 4004

In 1971, Busicom, a Japanese company, wanted a chip for a new calculator. With incredible overkill, Intel built the world's first general-purpose microprocessor. Then it bought back the rights for $60,000.

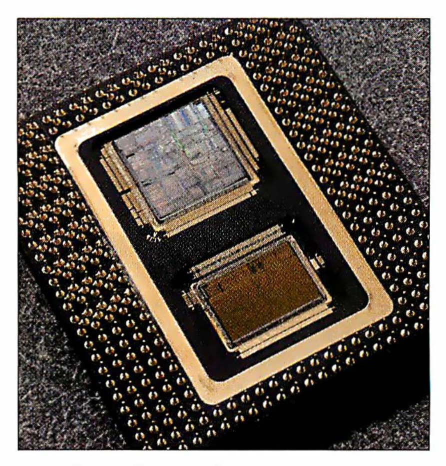
The 4-bit 4004 ran at 108 kHz and contained 2300 transistors. Its speed is estimated at 0.06 MIPS. By comparison, Intel's latest microprocessor, the P6, runs at 133 MHz, contains 5.5 million transistors, and executes 300 MIPS.

■ Intel 8080

If you drive, your life probably depends on this chip. Introduced in April 1974, the 8080 was first widely used as a traffic-light controller. It found its way a year later into the world's first personal computer: the MITS Altair.



THE INTEL 4004. IT WAS SUPPOSED TO BE THE BRAINS OF A CALCULATOR. INSTEAD, IT TURNED INTO A GENERAL-PURPOSE MICROPROCESSOR AS POWERFUL AS ENIAC.



THIS IS INTEL'S P6: ALL 5.5 MILLION TRANSISTORS, 133 MHz, AND 300 MIPS OF IT. IT'S ROUGHLY 5000 TIMES AS FAST AS THE 4004. YOU'VE COME A LONG WAY, x86.

■ MOS Technology 6502

What do a Nintendo set and a BMW have in common? The 6502. At $25 (compared with $375 for a comparable Motorola part), the 6502 was such a steal that a talented but cash-poor whiz kid from Silicon Valley, Steve Wozniak, chose it for his new personal computer, the Apple I.

■ Zilog Z80

Remember Tandy's TRS-80 Model I? Remember CP/M? They were both built on the Z80.

■ Intel 8086 and 8088

Enter the King. In June 1978, the 8086 debuted. Today it stands for the world's most popular microprocessor standard: the x86 architecture. A year later, Intel introduced a slight variation, the 8088, that could use 8-bit components, enabling the manufacture of inexpensive systems. For that reason, IBM chose the 8088 over the 8086 for the original IBM PC, even though the 8088 was slower.

■ Intel 386DX

The 386 heralded the beginning of a new age—the age of multitasking. Introduced in October 1985, the 386 was the first "modern" x86 processor that was capable of running today's multitasking OSes, GUIs, and 32-bit software.

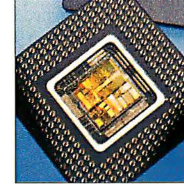
The 386 introduced an enhanced microarchitecture while maintaining full backward compatibility with earlier x86 processors. This was accomplished with two memory-addressing modes: real mode, which mirrored the way memory is addressed by the older x86s, and a new protected mode that took full advantage of the 386's 32-bit enhancements.

Chips

16 YEARS AGO IN BYTE

We published a simple program (220 bytes) to play Life on an 8080 system.

Returned exile and scholar Ayatollah Khomeini declares Iran an Islamic republic.



THE CHIP THAT LAUNCHED 68000 MACINTOSHES.

IT DIDN'T DIVIDE, BUT IT CONQUERED ANYWAY.

■ Intel Pentium

The Pentium swept through the PC industry faster than any of Intel's previous chips. Although Intel's 486DX (April 1989) integrated an FPU and was much faster than the 386, it was the Pentium that introduced the next leap forward in the x86 microarchitecture: superscalar pipelines. Skeptics said a CISC architecture couldn't do it. The Pentium proved otherwise.

■ AMD 386DX

Let the price wars begin. When Intel's original 16-MHz 386 was introduced in 1985, it cost $299; more than five years later, it was still commanding the relatively high price of $171, and the 33-MHz version fetched $214. AMD's 386DX/40 appeared in March 1991 at $281, but within a year its price plunged 50 percent to $140. Street prices of PCs, which follow chip prices, fell by as much as $1000. The market for Windows-capable PCs expanded by 33 percent.

■ Motorola 68000

More than any other, this is the microprocessor that helped establish the GUI. In 1983, four years after its introduction, it appeared in Apple's Lisa, a unique computer but a commercial flop that nevertheless paved the way for the Macintosh in 1984.

■ Mips R2000

The R2000, introduced in 1986, was a 32-bit CPU with 110,000 transistors. It powered the first generation of RISC workstations and servers. The original version, clocked at 8 MHz, executed about 5 MIPS and had a separate FPU.

■ Sun Microsystems SPARC

In July 1987, Sun announced an open RISC architecture. The idea was to encourage multiple sourcing and lively competition that would spur performance and spread the SPARC standard far and wide. Eight years later, SPARC workstations and servers dominate their markets.

■ IBM/Motorola PowerPC 601

Although few doubted the power of the PowerPC architecture, many thought the politics of the IBM/Motorola/Apple relationship was going to be unmanageable. In less than two years, it has spawned the world's most popular RISC platform: the Power Macintosh.

■ Chips & Technologies AT Chip Set

IBM is not known for its approach to open systems. So, while it was actively resisting the cloning of its PC architecture, C&T was introducing its AT Chip Set. With only five chips, C&T duplicated the core logic of about 100 chips in IBM's system. All a clone maker had to do was add a 286, a Phoenix BIOS ROM, and some memory to create a PC. Take that, Big Blue.

■ Amiga Agnes/Denise/Paula

It's not a rock group: This was the advanced chip set that powered the world's first multimedia computer: the Commodore Amiga 1000. In 1985, these three chips could do tricks that today's PCs and Macs still can't do—such as display multiple screens with independent pixel resolutions and bit depths on a single monitor.

■ Commodore SID

You can get remarkable results when you tell an engineer to do what he thinks is right. Take SID (Sound Interface Device), for example. In 1981, Bob Yannes was told to design a low-cost sound chip for the upcoming Commodore 64. He would end up creating an analog synthesizer chip that redefined the concept of sound in personal computers.

■ Yamaha OPL-2

Tweet. Beep, beep. Name that tune! The original IBM PC's sound capabilities were practically nonexistent—a simple beeper that could produce a limited range of square-wave tones. Yamaha's OPL-2 enabled vendors such as Ad Lib and Creative Labs to introduce plug-in sound boards with reasonable (but not great) sound. Today, nearly all PCs come with a sound board.

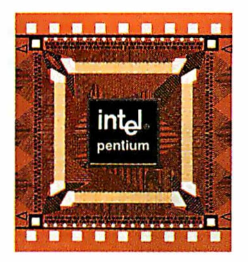
■ S3 911

Because PCs originally had character-oriented displays, screen performance drastically bogged down when running Microsoft Windows and graphical applications. IBM's 8514 chip and its spin-offs provided some improvement, but the market broke wide open in 1991 when S3 introduced the 911, which integrated GUI acceleration and VGA compatibility on a single chip.

■ Intel Mercury

The PCI (Peripheral Component Interconnect) bus is the most important enhancement to the PC architecture since the ISA bus, and Mercury was the first implementation. Today even Apple has adopted PCI to replace the NuBus.

GET PENTIUM.



Pentium™ Power:
The super-quick Pentium™ processor is designed specifically for notebooks and is engineered to perform 91% faster than 75MHz Intel DX4™ processors.

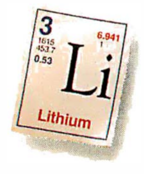
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CD-ROM to Go:
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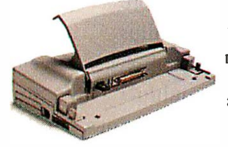


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Now you only need one computer. The new, optional Enhanced Port Replicator provides two Type III PC Card slots, and allows one-step connection to your desktop environment.



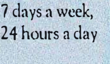
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A built-in power supply means you don't have to carry a bulky external AC adapter. This slim power cord is all you need.

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400CDT:
- 10.4" dia. coloractive matrix display
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- 10.4" dia. color dual-scan display
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BOTH MODELS:
- 75MHz Pentium™ processor (2.9v)
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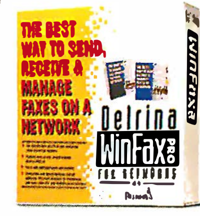
All specifications and availability are subject to change. † 400CS comes with the modular FDD only. A Quad-Speed CD-ROM is available as an optional upgrade. *The 400CS is sold at selected retailers as the 405CS with additional pre-installed software.

Circle 249 on Inquiry Card.

The Amazonian piranha uses razor-sharp teeth to rip out bloody chunks of your quivering flesh until you thrash and convulse in mind-numbing agony and plead for someone to kill you.

[Sort of like using someone else's network fax solution.]

Everyone knows that network faxing is an amazingly convenient way for people to fax right from their PCs. So there's no more schlepping to the fax machine. Everyone also knows it's agonizingly painful to implement. But now there's Delrina WinFax™ PRO for Networks 4.1. Which does for network faxing what Delrina WinFax PRO™ did for personal faxing. Which is to finally make it easy. Installing it takes no time. It's simple to add users and modems. Sending a fax from any Windows application is as easy as printing a document. And since people share phone lines and modems, you save money. See your dealer or call us at 1-800-598-8679 for more information about WinFax PRO for Networks. And go ahead and jump right in to network faxing. The water's fine.



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4 Most Important Networking Products & Standards

BYTE 20TH ANNIVERSARY REPORT

Twenty years ago, networks were three-letter corporations that owned television. Today, they are the fabric of our information society. Following are the products that form the woof and warp of this new world.

■ SNA

IBM's mainframe networking standard, SNA (Systems Network Architecture), is arguably the major milestone in networking technology in the last 20 years. Virtually every Fortune 500 company's mainframe networks are based on it, as well as any other company that has an IBM mainframe. SNA, officially introduced in 1974 with products becoming available in subsequent years, gave users access to the enormous amounts of data stored on mainframes.

With SNA, IBM developed a layered approach to communications that was to be the basis for all the company's subsequent data communications work.

■ DECnet

Introduced in 1975, DECnet supported communication over a variety of networks, including Ethernet LANs and baseband and broadband networks. DEC adapted its architecture to interconnect workstations, terminals, PCs, Macs, PDPs, and VAXes.

Because of an architecture that put intelligence at each network node, and because of the connectivity to PDPs and VAXes, DECnet was widely embraced by research and academic communities.

■ TCP/IP

A funny thing happened while we were all waiting for OSI to take off. A stopgap networking solution developed years ago by the Department of Defense's Advanced Research Projects Agency, TCP/IP, blew OSI off the map.

Between 1978 and 1980, the Defense Advanced Research Projects Agency developed and deployed the Transmission Control Protocol/Internet Protocol on its Arpanet. Today, TCP/IP is used in most large corporate networks to give users access to a wide variety of platforms on different networks. It is also the protocol of the Internet. Enough said.

■ Oracle SQL

If any one standard is responsible for the current boom of client/server networking, it's the database language SQL (Structured Query Language). Related to IBM's massive mainframe database DB2, SQL was brought to minicomputers in the late 1970s by the prescient Oracle corporation, which eventually ported SQL down to microcomputer LANs and stand-alone PCs (and even the Sharp Wizard—but nobody's perfect). Oracle's SQL became one of the first truly scalable applications development platforms. You could write and test your application on a workstation and then upscale it to your big iron when it was ready. Or better yet, you could downsize your mainframe apps to less expensive and more efficient systems, like PC networks.

SQL is such a popular standard that today, every major client/server application supports it; no competing architecture has come close.



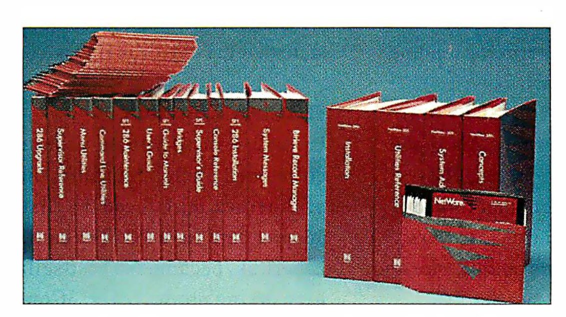
MANAGING A MESS: HP'S OPENVIEW CONSOLE



U.B.: HUBBA, HUBBA, EH?



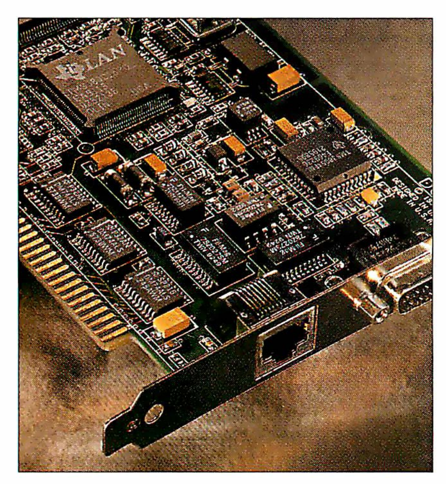
LONG BEFORE PCMCIA, XIRCOM WAS PLUGGING PORTABLES INTO ETHERNET.



BOOKS. LOTS AND LOTS OF BOOKS. SOMEWHERE IN THERE IS THE ACTUAL NETWARE 3.11 SOFTWARE. BUT WHERE? WE'LL NEVER TELL.



Most Important Networking Products & Standards



WE CAN THINK OF EXACTLY 3270 REASONS THAT ATTACHMATE'S IRMA BOARD, WHICH CONNECTS PCS TO MAINFRAMES, WAS AN INCREDIBLE SUCCESS.

■ Group 3 Fax standard

Remember being amazed when a fax machine could transmit a page in less than 30 seconds? That increase in speed was due to the CCITT's Group 3 recommendation for fax tranmissions. Issued in 1980, the Group 3 fax standard specified transmission rates of up to 9600 bps and included built-in compression, which made it possible to transmit a typical page in less than 30 seconds.

■ Ethernet

Today, when most office workers hear the name Xerox, they think of the photocopier machine, or they erroneously use the corporate name as a verb. We could just as well be using *Xerox* as a term for sending a file down the network wire.

In 1981, Xerox made history by introducing the original Ethernet LAN in the form of its Star Ethernet Series. The LAN was an office system that linked devices, such as workstations, servers, and printers, so that users could share and print documents.

The Star Ethernet Series was the result of Ethernet research conducted by Xerox with DEC and Intel. It was the first introduction many corporate users got to LAN technology. Xerox was a name player in the office market, and thus its sales staff at least had a foot in the door of most corporations.

■ NetWare and Sharenet

In 1981, Novell introduced Sharenet, the first product in the line, which soon became NetWare. It took the simple idea of dedicating one node on a network as a central resource and developed it into the most highly used NOS today.

Novell was not the only company in that newly emerging NOS market. Other early players included IBM and 3Com. But NetWare, especially versions 2.x and 3.x, delivered the features that organizations needed most: solid file and print services.

■ Hayes Smartmodem

Before 1981, modems were just plain dumb. They had no memory, and they couldn't recognize commands. The early modems simply did as their name implies: they modulated and demodulated signals.

With the advent of the Hayes Smartmodem in 1981, modems understood and could execute commands (the Hayes AT Commands) on their own.

The Smartmodem and the Hayes command set became the standard for modem communications and made Hayes the dominant player in the market for the next 10 years. Even today, most modem ads still state that the device is Hayes-compatible.

■ 3Com Etherlink

In 1982, a small Silicon Valley company cofounded by Bob Metcalfe, the inventor of Ethernet, introduced the first Ethernet adapter card for a PC. The card, the Etherlink, became the best-selling networking product ever. 3Com, Metcalfe's company, also developed its own NOS (network operating system) with which to use its new creation and drive the sale of its core hardware product.



■ The Irma board

The Irma board has to be the one product that symbolizes the acceptance of PCs by the corporate world. Before Irma's introduction in 1982, corporate data, which resided on IBM mainframes, was accessed through 3270 terminals. From these 3270 terminals, users could view data and run applications that printed reports.

In the early 1980s, as PCs started to make their way into corporations, there was a cluttering on the desktop. A terminal and a PC took a lot of room—especially those early IBM PCs with their large footprints.

Technical Analysis, soon to be acquired by Digital Communications Associates (DCA), developed a brilliant solution. Their Irma board, which plugged into a slot in an IBM PC, could give the PC user access to the mainframe data. The board included 3270 terminal emulation software and a coaxial-cable connection on the back to attach to the IBM network infrastructure.

■ Streettalk for Vines

Today, many corporations are looking for some way to easily keep track of resources and people on their networks. Ultimately,

Now Everyone Can Have The Superior Monitor.



If you've always wanted a top performing monitor, now is the time.

Even the coolest dudes find Nanao's new 17" monitors way cool. The new F2·17EX and T2·17TS models can't be beat for the ultimate in text and graphics performance. Which is why they're setting sales records at savvy computer stores. Another reason is Nanao's Windows 95 Plug & Play* compatibility. Complicated user set-up adjustments at the time of installation are virtually eliminated. And switching resolutions on-the-fly is a snap. Users are also drawn by Nanao's reputation for outstanding long-term reliability plus the stunning array of new advanced technical features that are ideally suited for graphical environments. Nanao even offers a choice of four 17" models to satisfy your budget, application requirements and tube preference. The F2·17EX features an ultra fine dot pitch Invar shadow mask flat-square tube, while the T2·17TS features the new hybrid technology aperture grill tube. Both monitors provide the power you need to achieve true-to-life colors, crisp typography and a stable screen image. Flicker-free resolutions up to 1280 x 1024 @ 82Hz refresh rate, Colorific™ screen/printer color matching software and on-screen image controls deliver previously unheard of levels of performance. For added safety against emissions, TCO compliance is now available as a standard feature.

If you're wondering why this dude looks so satisfied, it's easy to figure out. He just caught the perfect wave. And the perfect 17" monitor.

F2·17EX

Dot Pitch	0.26mm
Actual Viewing Diag.	16.1"
Scan Freq.	H:30-86kHz, V:55-160Hz
Rec. Resol.	1280 x 1024 @ up to 82Hz
Max Resol.	1600 x 1200 @ up to 66Hz
On Screen Control	ScreenManager™ and ScreenManager™ Pro
Standards	MPR-II, TCO, FCC B

T2·17TS

Grill Pitch	0.25mm
Actual Viewing Diag.	16.0"
Scan Freq.	H:30-86kHz, V:55-160Hz
Rec. Resol.	1280 x 1024 @ up to 82Hz
Max Resol.	1600 x 1200 @ up to 66Hz
On Screen Control	ScreenManager™ and ScreenManager™ Pro
Standards	MPR-II, TCO, FCC B

*3-year warranty***





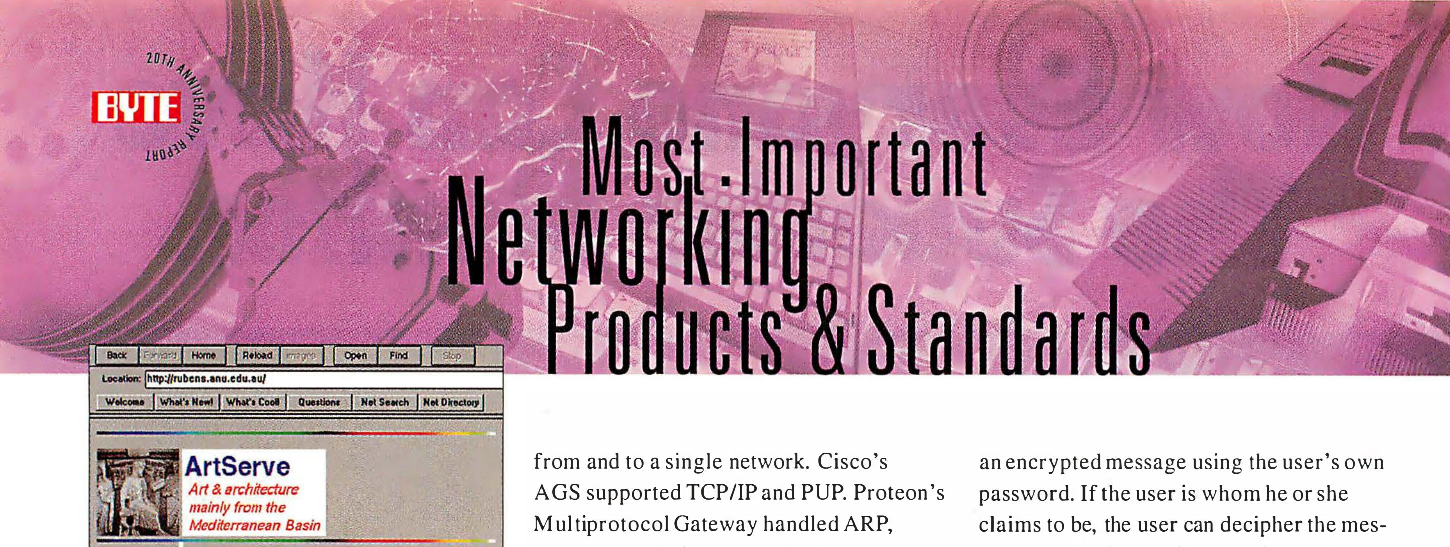
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Most Important Networking Products & Standards

MOSAIC IS LIKE THE FAIRY GODMOTHER OF THE INTERNET, TURNING IT FROM TEXT RAGS TO GRAPHICAL RICHES.

they'll probably use some form of a standards-based directory service, perhaps the ISO's powerful X.500.

In the meantime, they are stuck with stopgap solutions—unless, of course, they are Banyan Vines users. Since 1984, Banyan has offered its users Streettalk, its LAN-based directory services, which are needed in enterprise networks. Streettalk was the first of the enterprise directory services, and some say it is still the best.

■ Token Ring

IBM developed token-ring technology in the early 1980s, and the first commercial products hit the streets in 1985. Token Ring was based on the concept of using a token, which was passed around the network, to give a device access to the network. When a device needed to transmit data, it would seize the token. This technique made a token-ring network more deterministic compared with Ethernet's contention-based method for accessing the network.

The deterministic nature of Token Ring quickly became a popular choice for IBM SNA shops and it was quickly adopted by virtually all of IBM's large corporate customers as the way to link users throughout a corporation.

■ Cisco AGS multiprotocol router and Proteon Multiprotocol Gateway

These were the first routers to solve the problem of routing different protocols from and to a single network. Cisco's AGS supported TCP/IP and PUP. Proteon's Multiprotocol Gateway handled ARP, Chaosnet, TCP/IP, and PUP. We would like to award the laurel for first multiprotocol router to either Cisco or Proteon, but the companies are squabbling over who was first. Cisco, a source tells us, has produced the invoice for its first router sale and challenges Proteon to produce an earlier one.

■ ISDN

Still don't know? ISDN (Integrated Services Digital Network) is the phone system of the future. Fully digital and quite affordable, it offers enough bandwidth (64 Kbps) for acceptable Internet access and almost enough for videoconferencing. It's also a flexible system, offering scalability up to 1.544 Mbps (not coincidentally the same speed of a T1 line) for corporate sites. The downside of this noble mid-1980s standard is that it's really not standard at all—a lot of telephone markets implement the system differently, so bringing the next generation of communication into your home or business can be an exercise in frustration. Nonetheless, when analog modem technology runs out of steam (as it is beginning to do right now), ISDN will step in as the next great data communications standard.

■ Kerberos from MIT

In the mid-1980s, wizards at MIT developed Kerberos, a security system that controls access to network services. Their scheme requires that users be authenticated before they can get to any service on a network. Kerberos does this in an ingenious way. Users gain access to applications, data, printers, and so forth by using the equivalent of an electronic ticket, which is good for only one-time access and which, if the security administrator so desires, can expire within a fairly short time.

The system encloses the access ticket in an encrypted message using the user's own password. If the user is whom he or she claims to be, the user can decipher the message and the ticket will be available. The user's password is never passed over the network. Security is maintained.

■ OpenView

Enterprise network management was easier in the days of homogeneous networks. Companies whose networks were exclusively IBM, for example, would turn to IBM's NetView to manage all the devices on their SNA (Systems Network Architecture) networks.

That was fine until other vendors' products were introduced into a company's network—each with its own management system. Network managers had a deskful of monitors—one for every management system. They had to check the status of different devices on different monitors and assimilate all that information in their head. That was great for the aspirin companies, but for IS managers, it was impractical.

In 1988, Hewlett-Packard introduced OpenView to overcome such problems. OpenView was the first multivendor network management system. It also offered open APIs. Network equipment vendors could use these programming interfaces to make their products capable of being managed by the system.

■ Access/One

Today, virtually all corporate networks are built around intelligent wiring hubs that offer management capabilities and can isolate troublesome cabling flaws. The first commercial network to offer these features was Ungermann-Bass's Access/One hub. Before this, most local networks were made up of daisy-chained components, and a single cable flaw would crash the whole system. Next time you find a flaw that affects only one user and not your entire network, give thanks to Ungermann-Bass.


Thanks to Sprint Business,
Rail Europe increased its speed
to 256 kilobits per second.
Real Problem. Rail Europe, the exclusive sales agent for most European railways, needed a way to offer their huge database of schedule and fare information to travel agents all over the world.
Real Solution. Sprint Business put them on track with SprintNet,® the world's largest public data network, with access from 45 countries. What's more, with X .25 packet switching and highly reliable access at up to 256kbps, Rail Europe has quickly become the only stop for thousands of travel agents in the U.S., and as far away as Japan and Australia. All they need is a PC and the price of a local call to book virtually any train in Europe and the former Soviet Union. 24 hours a day.
Sprint Business technology helped Rail Europe.
Let us help *your* business do *more* business.

BYTE 20TH ANNIVERSARY REPORT

Most Important Networking Products & Standards

Cool Today, Hot Tomorrow

Four technologies stand apart, heralding the coming age of networking.

LAN Switches

LAN switches handle the heavier traffic that multimedia applications generate on networks by delivering more usable bandwidth to each desktop. They do this without requiring any change to the desktop; users keep their existing Ethernet or token-ring adapter cards in their PCs.

The most useful switching products will be those that can be modified to handle connections to higher-speed networking backbone technologies. While many of the switches already support FDDI (Fiber Distributed Data Interface) and Fast Ethernet connections, the switches that will truly play a major role in corporate networks are those that can accommodate ATM (asynchronous transfer mode) backbone connections.

Asynchronous Transfer Mode

ATM is the RISC architecture of the networking world: It uses fixed, 53-byte cells. This size is a compromise between the very long packets that would yield the best network performance and the very short frames that would give voice and video the smoothest functioning. Some argue that ATM is a kludge, but it's a kludge showing throughput of 622 Mbps, with future performance in the gigabit range. How far in the future? Considering ISDN's reception, maybe by 2000.

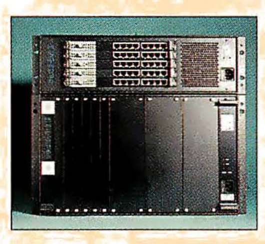
Voice/Data Integration

With more telecommuters and small offices requiring connectivity to corporate networks, companies are often paying for two lines to each location—one for a telephone and one to carry data. In many situations, the number of access lines to each site could be cut to one if the company could combine the voice and data traffic. Combining the two forms of traffic onto one line is becoming more practical. Some of the standout products making this type of convergence easier include:

- the MMV series of voice/data concentrators from Multi-Tech Systems
- the NetRunner Integration Router from Micom Communications
- the HTMA 200 integrated ISDN and analog modem and the DAS 925 product line from Motorola's Transmission Products Division

Computer Telephony Integration

For computer telephony integration, successful products will most likely be based on one or both of two approaches. The first is TAPI (telephony API), a programming interface developed by Microsoft and Intel that lets Windows applications access voice services and provides interoperability between PCs and telephone equipment. The second, the Telephony Services API, a programming interface developed by Novell and AT&T, offers a way to connect a PBX to a NetWare server and provides links between PCs and telephone equipment.



SOMETIME IN THE EARLY 1990S, ETHERNET PULLED THE OLD SWITCHEROO, AND ITS PERFORMANCE SKYROCKETED.

■ The Sniffer

In 1989, Network General introduced the Sniffer, a single tool that helped network administrators develop and troubleshoot LANs. Today, the Sniffer is synonymous with network analyzers.

The Sniffer offered detailed protocol decoding capability and let LAN managers set traps to watch for certain conditions. It could also capture a trace of all the traffic passing over a LAN segment. These features were (and still are) useful when trying to understand performance problems on a network or when troubleshooting a problem.

■ Xircom Pocket Ethernet Adapter

Similar to the way the Irma board symbolized the acceptance of the PC in the corporate world, the Xircom Pocket Ethernet Adapter symbolized the networked arrival of the laptop computer. Xircom had the brilliant idea of using a standard, universally available entry point into the laptop. The company's slick little box plugged into the parallel port—probably the only truly standard PC part. That gave every laptop user a quick and easy way to connect to a LAN.

■ Mosaic

The most important reason for the explosive growth of the Internet over the past year is the mass distribution of the Mosaic browser for the World Wide Web. Developed by the University of Illinois' National Center for Supercomputing Applications, Mosaic gives nontechnical people an easy tool with which to find their way around the Internet. Those who could care less about HTTP or HTML (Hypertext Markup Language) can use a Mosaic browser and weave their way through webs of information on their own.

Marc Andreesen and his lesser-known colleagues at NCSA deserve some sort of prize for their efforts. Not only did they invent a brilliant vehicle for navigating the Internet—but they gave it away.



The Best Things On-line

In 1975, the number of people going on-line was smaller than the membership of the Young Republicans for Captain Beefheart Fan Club. Now, those massive networks of computers and databases known as the on-line world have become an electronic extension of the tradition-al, off-line world.

■ Text Search Tools

Information is buried on the Internet. Tunneling its way to fame is gopher. If your site is gopherless, you can Telnet to **consultant.micro.umn.edu** and type *gopher* at the log-in prompt. Even better are WAISes (Wide Area Information Servers). If your system doesn't have a WAIS client, Telnet to **bbs.oit.unc.edu** and type *bbs* at the log-in prompt. Follow the directions.

■ Code Talk

Tools, languages, source code, tips and tricks, advice, and folks who've gone through hell. Sound good? Here are some of the best sites. For programming languages, anonymous ftp to **quartz.rutgers.edu** and take the path **/pub/computer/languages/***. For a discussion of the 32-bit Windows API, see the Usenet newsgroup **comp.os.ms-windows.programmer.win32**. For Unix, post your problem in the Usenet newsgroup **comp.unix.questions**.

■ Internet Directories

If Hercules were around today, one of his labors would be indexing the Internet. Luckily, someone has already done the work. Go to Yahoo at **http://www.yahoo.com**. Or, you can try the WWW (World Wide Web) Virtual Library. It's at **http://www.w3.org/hypertext/DataSources/bySubject/overview.html**.

■ Fun & Games

If you want to play in the MUD, see **alt.mud**, a good introduction to multiuser dimension games. Game Server at the University of Stuttgart provides a huge list. Telnet to **castor.tat.physik.uni-tuebingen.de** and type *games* at the log-in.

■ Technical Support

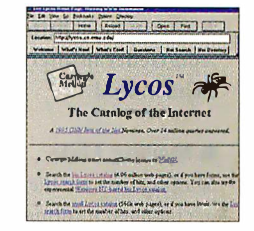
A Web page that you can visit to get technical assistance sure beats listening to cheesy music when you're on hold. Novell's home page is one of the best examples of how useful a Web site can be. Point your browser at **http://www.novell.com**.

■ Web Spelunkers

What if you need to find something on the Web fast? Lycos is from Carnegie Mellon University, and it's hot. Start at **http://lycos.cs.cmu.edu**. WebCrawler is good, too, at **http://webcrawler.cs.washington.edu/WebCrawler/WebQuery.html**. For its part, InfoSeek can pull information from anywhere. But it costs $9.95 a month. Send E-mail to **info@infoseek.com**.

■ Finder of Missing E-Mail Addresses

What if you don't have your recipient's address? Four11 is like an ace detective. To step into its office, E-mail **info@four11.com**, or point your browser at **http://www.Four11.com**.



LOST? GONE FOREVER? OH, MY! DARLING, DON'T YOU WORRY—SERVICES LIKE LYCOS WILL INDEX AND FIND CLEMENTINE IN A MATTER OF SECONDS.


The ORIGINAL Burp Gun!

1950's fun is back ... The original BURP GUN. It's safe ... it's exiciting ... and it's great for kids of all ages.

This is the original air-powered Burp Gun, the same one that's been produced since the 1950's. Burpco tracked down the original Italian manufacturer and brought the Burp Gun back to the USA. The Burp Gun's proven sales reflects the demand by adults rediscovering the childhood classic. And now, a new generation is discovering the Burp Gun for the first time.

Fun from the 50's is back for kids and grownups, too!

A BURP GUN? EXCUSE ME? ONLY ON THE INTERNET WILL YOU FIND LOVING RESTORATIONS OF SUCH ODDITIES AS THE BURP GUN. SPECIFICALLY, YOU'LL FIND IT (AND NEARLY EVERYTHING ELSE) AT YOUR LOCAL BRANCH MALL.



The Best Things On-line

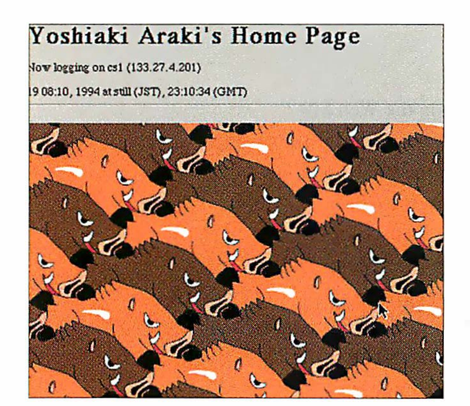
20 YEARS AGO IN BYTE

BYTE publishes its first issue; articles include "Write Your Own Assembler" and "Recycling Used ICs."

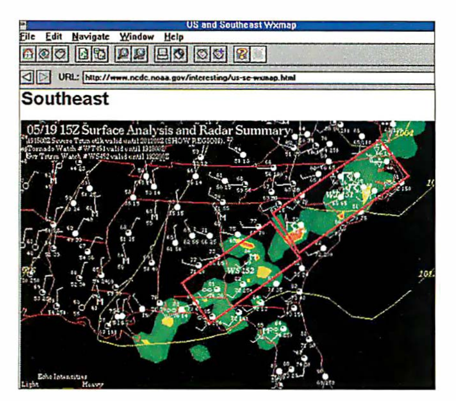
FBI agents capture kidnapped rich-girl-turned-liberation-soldier Patty Hearst.

■ Home pages
We like Netscape Communications' page: **http://www.netscape.com**. It's diverse and fun. But for serious computer talk, try the National Center for Supercomputing Applications at **http://www.ncsa.uiuc.edu/General/Internet/WWW/HTML Primer.html**.

■ Mailing Lists
Mailing lists are the most efficient way to get targeted information. An electronic version of Prentice Hall's *Internet: Mailing Lists* book is available via anonymous ftp to **ftp.nisc.sri.com** and follow the path **/netinfo/interest-groups**.



THE METROPOLITAN MUSEUM AND THE MOMA CAN EAT THEIR HEARTS OUT: THE INTERNET IS HOME TO ELECTRONIC VERSIONS OF SOME OF THE GREATEST ART EVER CREATED.



NO NEED FOR THE WEATHER CHANNEL. JUST TUNE YOUR BROWSER TO THE NATIONAL CLIMATIC DATA CENTER.

■ News
Online Today on CompuServe is the most timely source of daily computer news. But Clarinet distributes the *Dilbert* comic strip. Look for newsgroups that start with **clari**.

■ Travel Arrangements
With CompuServe, you can make air, hotel, and rental car reservations. Type *GO TRAVEL* and be on your way. On America Online, click on the Travel block.

■ Music
If you want to talk about music or keep up with what's new, the Internet's the place. For alternative bands, go to **http://www.iuma.com**. Or try out the Music Server: Anonymous ftp to **ftp.uwp.edu**; path is **/pub/music**.

■ Financial Information
If you haven't spent all your money on connect time, invest some of it. Clarinet provides the broadest range of financial and business information. **clari.biz.market** gives you the latest on the stock market and **clari.biz.invest** discusses IRAs, mutual funds, and other investment arcana.

■ Weather
If you want to know what's going on outside without having to look up from your computer, try the National Climatic Data Center's **http://www.ncdc.noaa.gov/interesting/us-se-wxmap.html**.

■ Education Resources
AskERIC, run by the Educational Resource and Information Center, is like a giant help desk for K–12 teachers. The address is **askeric@ericir.syr.edu**, or point your browser at **http://eryx.syr.edu/COWSHome.html**.

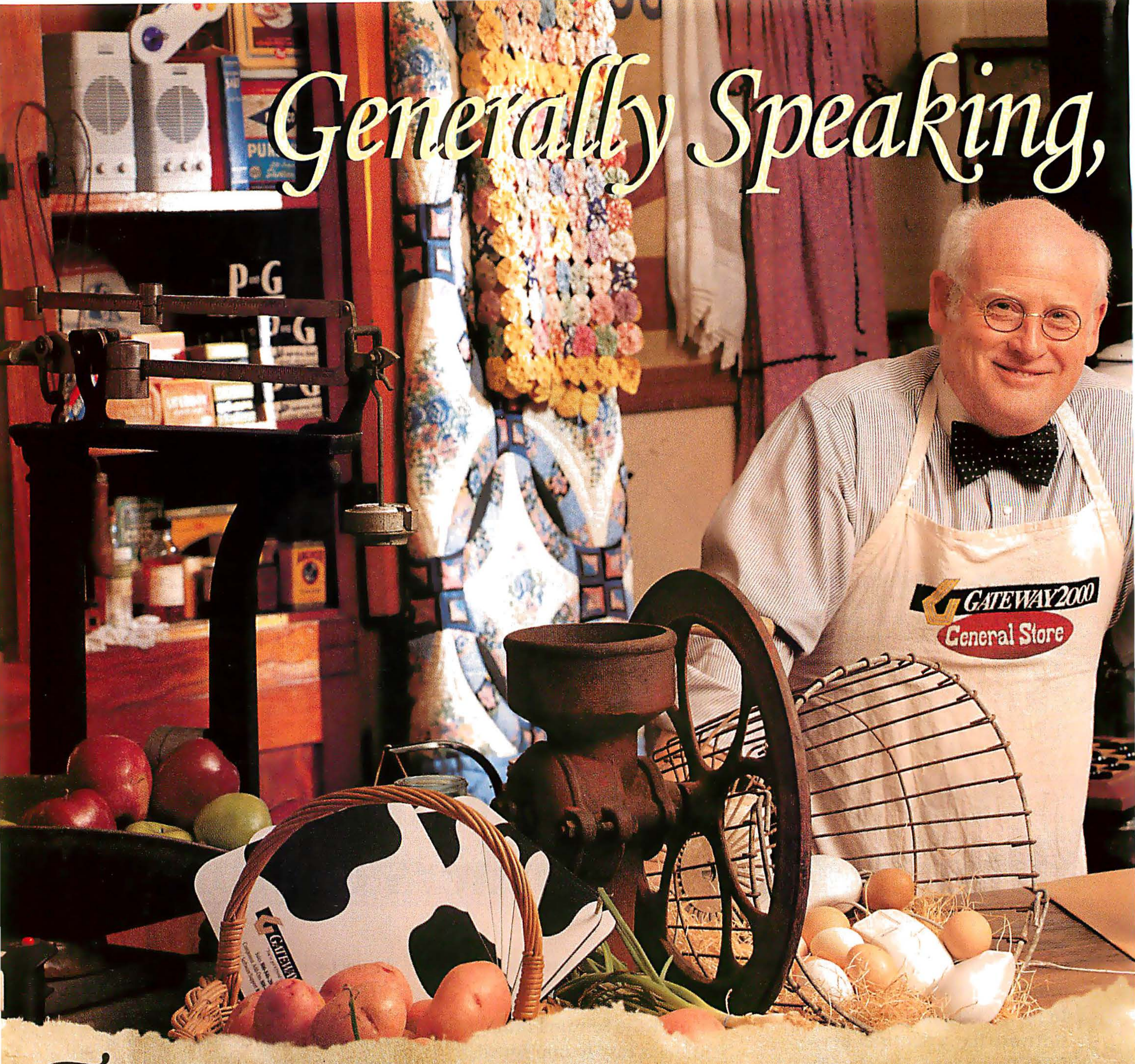
■ Sounds
If it's been recorded, it's on-line somewhere. Try the Usenet group **alt.binaries.sounds.misc**. And DSP Group's TsPlayer lets you play a WAV sound file before you download it. Anonymous ftp to **ftp://oak.oakland.edu/SimTel/win3/sound/tsplay100.zip**.

■ Free Software
All you have to provide is the shrink-wrap. For PC software, gopher to **merlot.welch.jhu.edu**. For Mac software, anonymous ftp to **oak.oakland.edu**; the path is **/pub2/macintosh**. You Unix mavens will find a C archive if you anonymous ftp to **wuarchive.wustl.edu**; use the path **/systems/unix/unix-c/***. Finally, you'll get OS/2 software at anonymous ftp to **ftp-os2.nmsu.edu**; the path is **/os2/***.

■ Art
From Mona Lisa to Beavis and Butt-Head, you can get a look at the digitized works of some of the world's greatest artists. Start with ArtMap at **http://wimsey.com/anima/ARTWORLDonline.html**. Then try ArtServe at **http://rubens.anu.edu.au/**.

■ Shopping
There's no re-creating the mall experience. Thank God. Start at the Branch Mall at **http://branch.com**. AutoPages is the place to shop for that new Lamborghini. Speed on over to **http://www.clark.net/pub/networx/autopage/autopage.html**.

■ Talk to Computer Companies
CompuServe's company forums are still the best places to tell vendors what you think, to talk with company officials. Join the Hardware and Software Forums for starters—most major companies have support forums on CIS.



There was a time you could find anything you needed at a general store. Nowadays Gateway 2000® can offer you that same neighborly service and wide selection of quality products.

We care about our customers. That's why Gateway offers a large assortment of cutting-edge, quality, professional desktop systems. Whether you need a solid 486 workstation or the power of the P5-133XL — we can help you out. Stocked with the latest technology, the P5-133XL includes a 133MHz Intel Pentium processor, 16MB EDO performance-enhanced memory, 256K pipelined burst cache, Matrox MGA Millennium graphics accelerator with 2MB WRAM, and MS Office 95 Professional Edition upgrade upon release. Plus you'll receive a three-year on-site warranty and priority toll-free technical support 24 hours a day, seven days a week with our new Gateway Gold Premium Service, standard only on the P5-133XL!

Gateway also has a Grade A inventory of portable PCs as diverse as our desktop line. At 4.2 pounds, the Liberty DX4-100 Base system is chock-full of features like an Intel 100MHz DX4 processor and 10.4-inch display. It's the perfect partner for your desktop PC, and when you're off for parts unknown. Our shelves are full of tantalizing options that include expanded RAM, lithium ion batteries, external CD-ROM drives, huge hard drives, fax/modems and PCMCIA network cards to satisfy any PC buyer's taste.

Times may change, but Gateway 2000's tradition of providing high-quality, feature-packed computers remains the same. And by ordering now, you'll reserve your copy of Microsoft's new operating system, Windows 95. Call Gateway today and talk to *your* friends in the business.

network users conquer time and space.

Be honest. As a technology leader people look to you for new ideas and innovative solutions. You've been successful. Now you have responsibilities. Demands on your time keep increasing. Your office never seems to be quite large enough. It's almost as if time and space have shrunk around you. You're cool except, that is, when you can't find something, then you go completely stark raving bonkers! Now at last a tool that is really going to help you. We call it EasiFile.

EasiFile is a complete network-ready electronic filing system. Designed to give you instant retrieval of all your paper based information, however vast. EasiFile deals with the very documents you find so difficult to file and find. Technical articles, CVs, reports, product specs, news releases, bills, even cherished letters from old friends can be scanned and stored quickly with fully automatic or structured indexing. With EasiFile you are master of you own information.

Because your time is so precious, we have designed EasiFile as a total solution. From the moment you open the box it's ready to work for you. Everything you need is included, pentium based system unit, network interface, scanner, optical storage, monitor, keyboard, mouse and, of course, the software.

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6 BYTE 20TH ANNIVERSARY REPORT

BEST Books & CD-ROMs

These are the books and CD-ROMs that have advanced the state of computing, that best chronicle the past two digital decades, and that manifest the innovative use of electronic publishing. Read on.

BOOKS

■ **The Art of Computer Programming**
Donald E. Knuth
(Addison-Wesley, 1973–1981)
The bible of all fundamental algorithms and the work that taught many of today's software developers most of what they know about computer programming.

■ **The Cuckoo's Egg: Tracking a Spy Through the Maze of Computer Espionage**
Clifford Stoll
(Doubleday, 1989)
Astronomer Stoll notices a tiny accounting error and ends up catching a spy in this real-life thriller. *The Cuckoo's Egg* is much more than your basic thriller, though; it raises extremely important questions about international on-line ethical behavior, which is an important issue in the information age.

■ **Fluid Concepts and Creative Analogies: Computer Models of the Fundamental Mechanisms of Thought**
Douglas Hofstadter and the Fluid Analogies Research Group
(Basic Books, 1995)
Whether you agree with Hofstadter's concepts or not, he has moved the AI debate beyond mere rhetoric to actually writing programs that can test the AI hypothesis.

■ **Fumbling the Future: How Xerox Invented, then Ignored, the First Personal Computer**
Douglas K. Smith and Robert C. Alexander
(William Morrow, 1988)
A sad tale of a company that comes up with so many brilliant ideas but lets them die in the R&D labs.

■ **Hackers: Heroes of the Computer Revolution**
Steven Levy
(Anchor Doubleday, 1984)
The best book there is about the unconventional brainiacs and code wizards who started it all.

■ **Inside the IBM PC**
Peter Norton
(R. J. Brady, 1983)
The Master of Utilities rolls up his sleeves and produces the first popular book to expose the innards of IBM's personal computer. One of the best tutorials on what's inside the box.

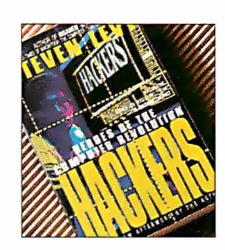
■ **Programming Windows 3.1**
Charles Petzold
(3d edition, Microsoft Press, 1992)
In its time, it was the ultimate guide for Windows applications developers.

■ **The Soul of a New Machine**
Tracy Kidder
(Little, Brown, 1981)
A true-life engineering adventure story.

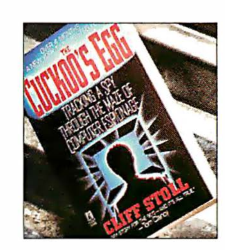
■ **Unauthorized Windows 95: Developer's Resource Kit**
Andrew Schulman
(IDG Books Worldwide, 1994)
What makes Windows 95 tick? Not only does Schulman tell developers about the code behind Windows 95, he tells them what decisions and tradeoffs Microsoft made.



STILL KIDDERING AROUND AFTER ALL THESE YEARS.



SOME WENT ON TO BECOME MILLIONAIRES. SOME WENT DIRECTLY TO JAIL.



INSIDE YOU'LL FIND A GREAT RECIPE FOR CHOCOLATE-CHIP COOKIES. REALLY.

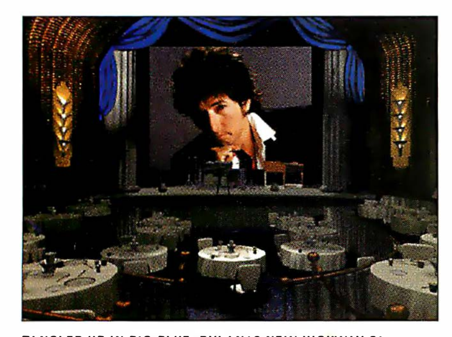
Best Books & CD-ROMs

■ Understanding Computers and Cognition: A New Foundation for Design
Terry Winograd and Fernando Flores
(Ablex, 1986)
One of the first books that explores for a large audience how computers fit into—and change—our lives.

CD-ROMS

■ Cinemania
Microsoft
A must for movie lovers. Great for settling trivia debates. Summaries of more than 19,000 films, from contemporary to classic. Updated annually. Nothing like it exists in book form. Many thumbs up.


THESE ARE THE VOYAGES OF THE STARSHIP ENTERPRISE—YOUR VOYAGES, THANKS TO SOME ASTOUNDING VIRTUAL REALITY.


TANGLED UP IN BIG BLUE: DYLAN'S NEW HIGHWAY 61 INTERACTIVE CD-ROM FOR THE PC.

■ Computer Select
Ziff Communications
Do you need to research a computer product or get a feel for what's hot? Do you want to find the printed buzz on a particular piece of hardware or software? Computer Select is the easiest way to search the full text of 28 computer magazines and abstracts from 110 other periodicals. Updated monthly.

■ Compton's Interactive Encyclopedia for Windows
Compton's Learning Co.
The best interactive encyclopedia keeps getting better. Maps, charts, animations, high-resolution pictures, and an easy-to-use interface bring the printed version's 32,000 articles to life.

■ Highway 61 Interactive
Graphix Zone
When you're lost in the rain in Juarez, and it's Easter time, too, turn on this disc to see just how good a CD-ROM can be. A Bob Dylan multimedia museum.

■ Mayo Clinic Family Health Book
IVI Publishing
Helps you understand anatomy, diseases, and health issues. Provides the full text of the 1378-page printed version, plus 500 narrated illustrations. Uses animations and video clips to explain basic physiological concepts. Has a slick morph-like animation of human anatomy.

■ McGraw-Hill Science and Technical Reference Set, release 2.0
McGraw-Hill
From the company that owns BYTE, this disc contains McGraw-Hill's *Concise Encyclopedia of Science and Technology* and the unabridged McGraw-Hill *Dictionary of Scientific and Technical Terms*. Your technical library just isn't complete without it.



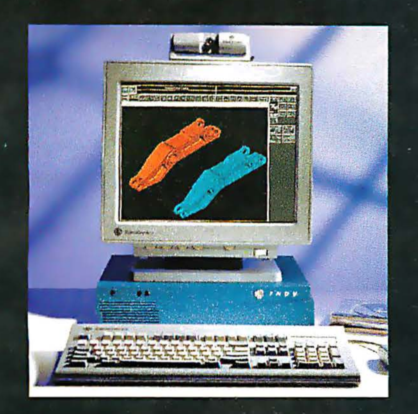
■ Microsoft Bookshelf
Microsoft
Tons of information at your fingertips, with some of it illuminated by audio and graphics. Includes *The American Heritage Dictionary*, *Roget's Thesaurus*, *World Almanac*, *The Hammond Intermediate World Atlas*, the *Concise Columbia Encyclopedia*, and the *Columbia Dictionary of Quotations*. Updated annually.

■ Myst
Broderbund Software
A fantastic fantasy game with great graphics, animation, music, and entertaining (if diabolical) puzzles. The first CD to bring a new kind of art to our society.

■ Star Trek: The Next Generation Interactive Technical Manual
Simon & Schuster Interactive
Apple's QuickTime VR panoramic video technology lets you explore the starship *Enterprise* and the entire Federation as never before possible.

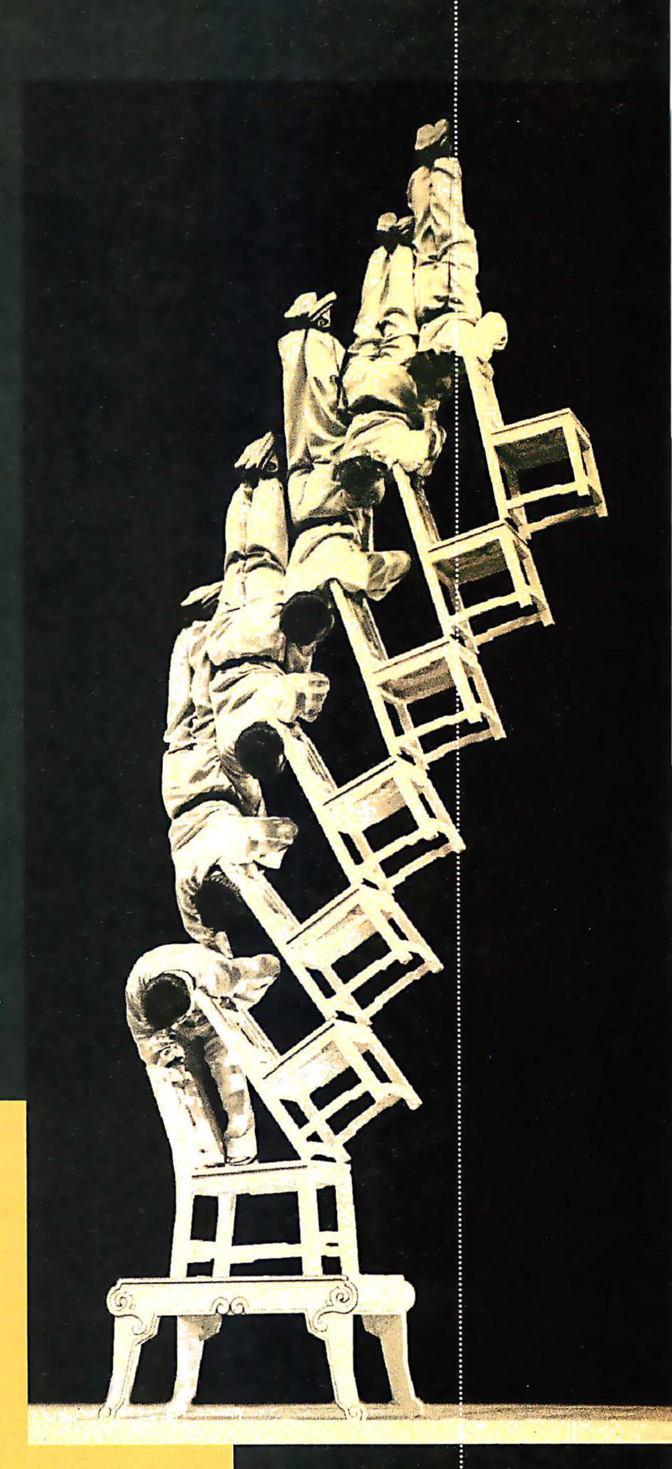
■ Taxi
Middlegate
Before you go to New York, Los Angeles, San Francisco, Chicago, and Washington, D.C., check out Taxi. It lets you create personalized city maps for the above cities, including Zagat Survey reviews and ratings of hotels and restaurants. Information becomes more important when it's personalized to your needs.

Silicon Graphics™
Computer Systems



There's only one thing about our computer that's not in keeping with industry standards.

The performance.



Indy Modeler. The affordable CAD/CAM/CAE solution.

There's one computer in the market that runs all major CAD/CAM/CAE software, supports network standards like TCP/IP, Netware™ and NFS™, comes standard with SoftWindows™ and innovative workgroup collaboration software, and gives you incredibly powerful 3D modeling performance.

Indy Modeler.™

So it's hardly surprising that it won the AIM Benchmark award for best price/performance in its class.

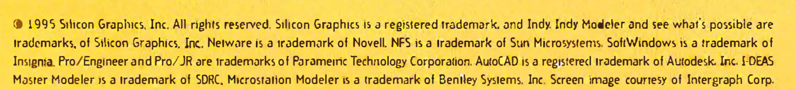
Indy Modeler runs all major software including Pro/Engineer,™ Pro/JR,™ AutoCAD® R13, SDRC–I-DEAS Master Modeler,™ Matra Datavision – Prelude and MicroStation Modeler.™

For copies of the Indy Modeler brochure and video, and the name of your nearest reseller, call 1-800-636-8184, Dept. D440, or visit us on the World Wide Web at http://www.sgi.com/Works.











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When the rush was on to introduce a notebook with a Pentium® processor, Texas Instruments decided to do what others thought couldn't be done.

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But our engineers didn't stop there. *We added a second lithium ion battery* without sacrificing size, weight or eliminating a floppy drive.

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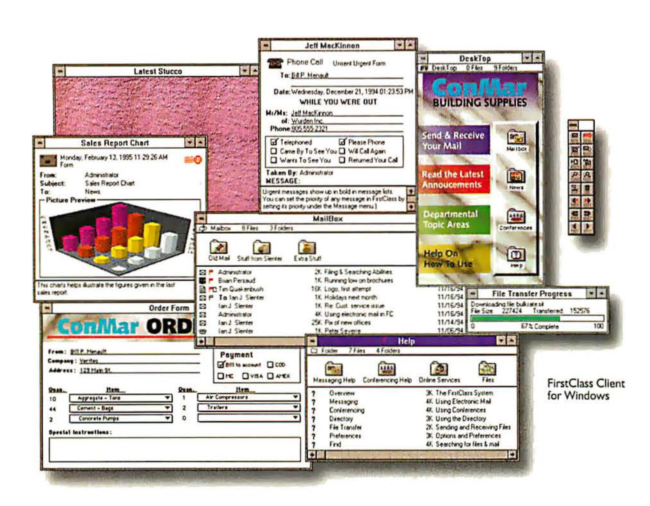
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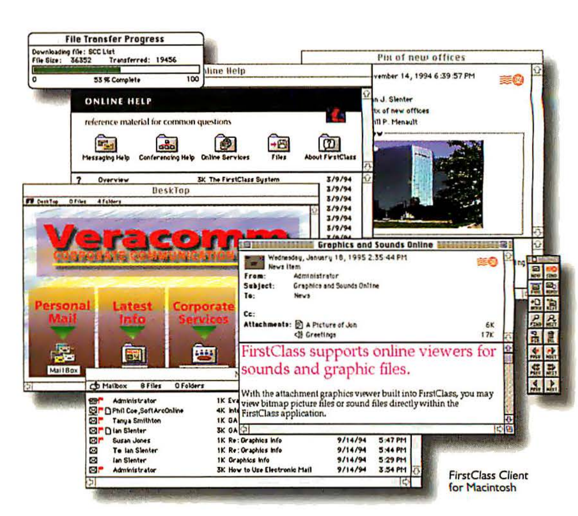




Circle 247 on Inquiry Card (RESELLERS: 248).



FirstClass Client for Windows



FirstClass Client for Macintosh

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Information Management
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1995 MacLife Japan Grand Prize
1994 MacUser Best New Communication Product Finalist
1994 Datateknik Sweden Editor's Choice Networking Software
1994 MacUser UK Editor's Choice Networking Software
1993 MacUser Best New Communication Product
1993 BYTE Award of Merit
1993 Macworld Germany E-Mail Product of The Year







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Circle 262 on Inquiry Card.



Remarkable Names of Real Computer Companies





SLIPPERY DISKS



PLAID BROTHERS SOFTWARE



SURFWARE, INC.

- **Techie Founder Division**
  PropellerHead Software
  Two Nerds and a Suit
  TechnoJock Software, Inc.

- **High Self-Esteem Division**
  Famous Engineer Brand Software
  Right Answers, Inc.
  Simply Outstanding Software

- **Divinely Inspired Division**
  Exodus Software
  Promised Land Technologies, Inc.
  Software Heaven

- **Natural Competitor Division**
  Dragon Systems, Inc.
  DragonSlayer Systems

- **Animal Division**
  Groundhog Graphics, Inc.
  Gecko Group
  Grizzlyware

- **What's the Concept? Division**
  Paradigm Concepts, Inc.
  Treacyfaces, Inc.
  Bio-Plum, Inc.

- **Home on the Range Division**
  Whiskey Hill Software
  Double R Software, Inc.
  Rancho Technology, Inc.

- **Clinton Administration Division**
  Algor, Inc.
  Hillary Software, Inc.

- **PUNitive PUNishment Division**
  Slippery Disks
  O'Pin Systems, Inc.
  CADapult, Ltd.

- **Spelling Checker Division**
  Konpyuta Software PS, Inc.
  Cykic Software, Inc.
  Aamazing Technologies, Inc.

- **A Certain Life-Style Division**
  SurfWare, Inc.
  No-Brainer Software, Inc.
  Relax Technology

- **Modesty Division**
  Functional Software
  Plain Jayne Software, Inc.
  Working Software, Inc.

- **New Words Division**
  Mathemaesthetics, Inc.
  BehavHeuristics, Inc.
  Pectronics Corp.

- **Science and Math Division**
  3rd Planet Software, Inc.
  Calculus, Inc.
  Entropy, Ltd.

- **Literature Division**
  Ozymandias Engineering
  Utopia Grokware, Inc.
  Bloomsbury Software Group, Inc.

- **Mythology Division**
  Odin Systems, Inc.
  Prometheus Products, Inc.
  THOR Computers

- **Negative Connotations Division**
  Glacier Software
  Screaming Technology, Inc.
  Missing Link Technologies

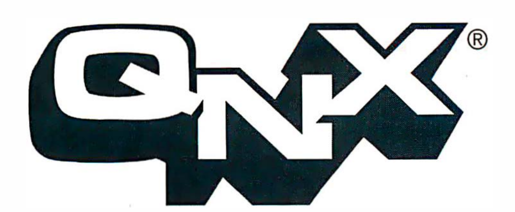
- **Living Color Division**
  Plaid Brothers Software
  Beige Bag Software
  Cobalt Blue, Inc.

- **Fruit and Vegetable Division**
  Electric Banana, Inc.
  Okra Marketing Corp.
  Radish Communications Systems, Inc.

- **Mineral Division**
  Night Diamonds Software
  Onyx Computing, Inc.
  Sapphire Systems, Inc.

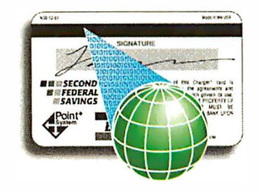
- **Uncategorizable Division**
  Grumpfish, Inc.
  Boojum Computer Systems, Inc.
  Gunning Wordnology

PRESENTING THE
PHOTON™ microGUI
AT THE EMBEDDED SYSTEMS CONFERENCE
Booth 1433



The Leading Realtime OS for PCs

So you've chosen Intel® processors for your embedded systems. Smart choice, given the great variety of form factors, buses, and software support for non-desktop PCs. Now go with the leading realtime OS for PCs.*



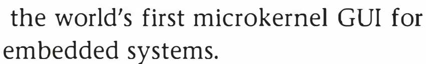
With QNX's successful 14-year track record and huge installed base, you can count on a realtime OS that's been proven time after time in the real world.

Scale it on the Fly As a modular, microkernel-based OS, QNX lets you add or subtract modules to fit your platform —from PDAs up to workstations equipped with X and TCP/IP. You can start and stop modules at run time *without rebooting your system!* Even our runtime pricing is modular, so you pay for only the OS modules used in your target systems.

Open Embedded Systems QNX is the *certified* POSIX OS that performs like a dedicated real-time executive. You get the rich API and tools of an open-systems OS, all in a scalable package that can fit on everything from tiny ROM-based systems to vast distributed LANs.

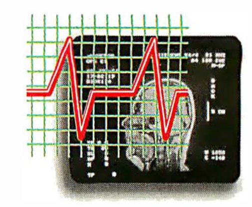
You'll like the tighter, faster code you get with the Watcom C/C++ optimizing compiler. Not to mention the time you'll save with our distributed debugger, profiler, and trace analysis tools.

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*According to a recent report by Emerging Technologies Group, QNX has "the largest realtime operating system marketshare in the Intel® 80X86 marketplace."

Circle 238 on Inquiry Card.

8 Most Important Companies

20TH ANNIVERSARY REPORT BYTE

Which of the 5000 computer companies got us where we are today? Here are the top 20.

■ Adobe Systems

As if inventing and commercializing PostScript weren't enough, Adobe also developed most of the tools of the desktop publishing revolution: Photoshop, Illustrator, and, of course, scalable fonts; and it acquired Aldus PageMaker, the program that practically defined desktop page layout. Adobe's influence in document production has grown from the desktop to the prepress shop. It has also reached into other creative domains: Its Premiere video-editing suite could be the training studio for the Martin Scorseses of digital cinema. John Warnock and Charles Geschke have been steering the company through the foggy nightscape of electronic documents. Whether or not Acrobat will become the interchangeable document standard, as PostScript did for printing, it has made a permanent mark on desktop publishing and computer graphics.

■ Apple Computer

This might be something to argue about, but you could make a good case that Apple has had more influence on personal computing than any other company. Who personifies the industry, the culture of personal computing, more than Woz the electronics whiz and Jobs the dynamo salesman—the engineer and the entrepreneur—hopping with ideas, quitting their day jobs, working in a garage, and selling a VW microbus to finance the company?

The affordable Apple II turned thousands of people on to computing. Then came the Mac, for years the computer that Intel-based PCs wanted to be when they grew up, with its graphical interface, built-in networking, and plug-and-play design. As it's done for nearly 20 years—something very few clone makers can say—Apple continues to influence the state of personal computing.

■ AT&T

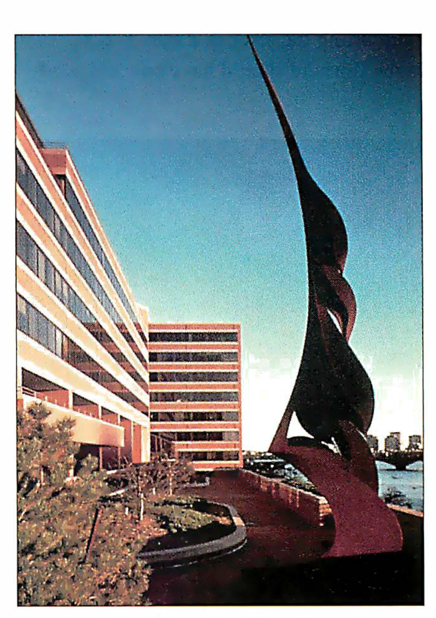
Its attempts to build personal computers have never been anything to call home about. (Can you remember the PC 6300? Did you ever even hear of it?) But AT&T has contributed three things of monumental importance to computing: Unix, the phone system, and the cumulative genius of the researchers at Bell Labs. Even those tedious "You Will" ads can't overshadow these significant accomplishments.

■ Autodesk

CAD on a personal computer? You've got to be kidding. But John Walker and his 12 programming disciples weren't. When they started Autodesk in 1982, their objective was a PC software package that would provide 80 percent of the functionality of a mainframe CAD system at 20 percent of the price. Later that year, they shipped AutoCAD. It couldn't do everything a mainframe program could, but it was good for the kinds of things most designers do. Plus, it was affordable—you no longer had to be Boeing to have a CAD system. Today, with a million copies sold and versions across all major platforms, AutoCAD is the uncontested champ of desktop CAD. Other companies have built better, easier-to-use, less expensive CAD programs—but every



AN ARTIST'S REPRESENTATION OF MICROSOFT HEADQUARTERS (IT COULDN'T BE REAL—IT'S NOT RAINING).



HARVARD UNIVERSITY, MIT, AND THE TASTY: ALL CONTRIBUTING PEOPLE AND KNOWLEDGE TO LOTUS.

Most Important Companies

15 YEARS AGO IN BYTE

Tandy introduced its TRS-80 Model III.

The U.S. Supreme Court ruled that the public has a right to attend criminal trials.

one of them has one thing in common: the AutoCAD file format. More than anything, that says Autodesk defined PC CAD.

■ Borland International

In 1983, a year of major announcements—the XT, NetWare, Windows—one of the biggest splashes, a Pascal compiler for $49.95, was made by this obscure company. Turbo Pascal wasn't just cheap. It was fast, and it was good. With one successful ad in BYTE, Turbo Pascal launched Borland into the stratosphere of micro software companies. More important, it made Pascal programming affordable. Borland killed the notion that languages and programming tools had to be expensive to be good. In 1987, with Quattro Pro, they did the same for spreadsheets, substantially undercutting the price of Lotus 1-2-3. Maybe Borland should have concentrated on programming tools—like its recent Delphi—instead of getting caught up in price wars and Lotus lawsuits. Regardless, Borland tools have been adopted by a generation of developers, and the company's impact on software prices has been good for users.



COURTESY OF APPLE COMPUTER, INC.

SILICON VALLEY'S NUMBER ONE AMUSEMENT PARK: THREE FLAGS OVER CUPERTINO.



ARMONK? WHOEVER HEARD OF HEADQUARTERING A COMPANY IN ARMONK? FOR THAT MATTER, WHOEVER HEARD OF ARMONK?

■ Commodore International

Commodore's role as a personal computing pioneer is sadly overshadowed by its business failures. But along with Apple and Tandy, it was one of the 1977 Trinity: the three companies who brought out ready-to-run PCs. The Commodore PET had a built-in monitor, a tape drive, and a bargain price of $795. Then came the VIC-20, the industry's first million seller. No wonder; it was a color computer that cost less than $300. The string of hits continued with the Commodore 64. Not only was it possibly the biggest seller of all time, it was the first with a synthesizer chip. Then, in 1985, came the world's first multimedia PC: the Amiga, a classic example of a product ahead of its time. Besides design innovations, Commodore's other big contribution can be summarized by the slogan of its founder, Jack Tramiel: "Computers for the masses, not the classes."

■ Compaq Computer

Houston, Texas, February 1982: Three men sit in the House of Pies kicking around a product idea. A year later, their newfound company would ship the Compaq Portable. (They shipped 53,000 of them that year.) The computer in the famous sewing machine case could run all the software developed for the IBM PC. It became the benchmark of PC compatibility. Because of its dedication to solid engineering, Compaq also became the benchmark of quality. Even True Blue shops learned to trust the brand. Compaq made it OK to buy a clone. Other clones sold for less, but if you bought a Compaq, you knew you didn't have to hold your breath and cross your fingers every time you fired up Lotus 1-2-3. Plus, you could carry the thing home. (Does that mean we should blame Compaq for the extension of the workday?) Did those three guys in the pie shop know how big their PC clone idea would become?

■ CompuServe

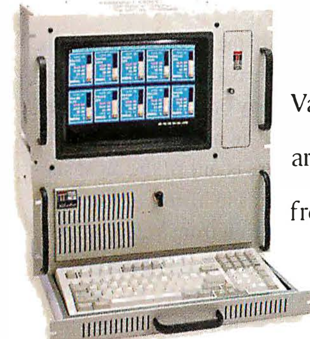
Much of what we expect on an on-line service, we expect because we saw it on CompuServe: forums, vendor support, free software, newswires, and E-mail to everywhere; business and personal services; reliable global communication; and most recently, access to the Internet. CompuServe turned the switch on-line in 1979 and now claims more than 2.5 million users. For a good portion of the PC public, CompuServe is what it thinks of when it thinks of going on-line.

■ Digital Equipment Corp.

If DEC founder Ken Olsen had had his way, the company probably wouldn't be on this list. After all, this is the man who said, essentially, that the destiny of home computers was in the closet. Despite Olsen's antiquarian contrarian attitude, Digital made some significant contributions to personal computing—especially networking in academic environments. Once it acknowledged the personal computer as a business machine, it proceeded wholeheartedly to produce superb networking equipment; today, it's a leading hub vendor. Digital also helped advance Ethernet and FDDI, and it developed the spanning tree bridging algorithm that many large companies used to build their enterprise

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Circle 272 on Inquiry Card (RESELLERS: 273).



Most Important Companies

WEIRD ERROR MESSAGE NO.4

>HAPPY BIRTHDAY!

(sole response from a malfunctioning motherboard)

networks before multiprotocol routers began to adopt other algorithms.

■ IBM

Why does everyone make fun of IBM's failures? It's the butt of more jokes than Rodney Dangerfield's wife. But in 1981, the computing giant brought out the IBM PC. IBM might as well have called it the DFS, for de facto standard. If that doesn't earn the company a place in history, then consider these inventions: the Winchester disk drive, the floppy disk drive, and the laser printer. In some ways, you might also put Microsoft on IBM's list of inventions.

■ Intel

All those millions of x86 chips; the dominant computing architecture; the Pentium franchise. Any questions?

■ Lotus Development

People thought it was crazy when upstart Lotus announced it was bringing out a spreadsheet program. VisiCalc was king. But Lotus had a good idea—combining worksheet, calculation engine, and graphics functions into one product. And Lotus had the brilliance to go after the next big thing instead of fighting for the current big thing. That next big thing was the IBM PC. Lotus developed its spreadsheet program for IBM's machine, not the Apple II. Smart move. For the next decade, Lotus owned the spreadsheet market. Even though competitors have taken away a big share, those competing products all look suspiciously like Lotus 1-2-3. Whether or not Lotus can dominate with its innovative Notes software remains to be seen (IBM surely thinks so), but its investment in this groupware technology shows traces of the foresight that inspired the creation of Lotus 1-2-3.

■ Microsoft

Once upon a time, these two guys wrote a version of BASIC for microcomputers. Then they acquired this OS, which they renamed MS-DOS. Then they made this once-in-a-lifetime deal with IBM. Then they sold millions of copies of Windows. Then they ruled the world. The End.

■ Motorola

Galvin Manufacturing Corp. helped make car radios ubiquitous in the 1930s. Forty years later, under the name it used to brand those mobile radios—Motorola—the company helped make semiconductors ubiquitous. Its 6800 chip inspired the inexpensive 6502 (developed by ex-Motorola engineers who had defected to MOS Technology) that Steve Wozniak picked to be the brain of his new computer. Later, Motorola's influence was more direct: Apple could afford the 68000 series for the Macintosh.

■ Novell

Other companies also came up with software to connect personal computers, but Novell was smart enough to design an open network OS with hooks. It was willing to work with other parties to enhance the system. While partners were developing extra goodies, Novell focused on the core OS. It got out of the hardware business and concentrated on its sure thing: connectivity software. The result is NetWare's position as the king of NOSes (network OSes), the means by which millions of PCs are connected.

■ Shugart/Seagate

When Shugart Associates brought out its 5-MB 5¼-inch hard drive in 1980, the company started something as big as the drive's capacity seemed to be: the idea that personal computer users could have their own massive storage device, right there, at a reasonable price. Five megabytes—how could you ever fill that much space? Four years earlier, Shugart had introduced another breakthrough: the 5¼-inch minifloppy for $390. The company also originated the concept that became SCSI; in 1979, it proposed a general-purpose expansion bus called Shugart Associates System Interface, which eventually became an ANSI standard known as SCSI-1.

Alan Shugart went on to head Seagate, today one of the leading makers of hard disks. Seagate has continued the Shugart tradition of innovations in storage technology. By the end of this year, you'll be able to buy a 1-GB drive for $300. This kind of low-cost, high-capacity storage is the legacy of Shugart and his engineering team at Shugart Associates.

■ Sun Microsystems

Sun set out in 1982 with an objective that the big guys scoffed at: to build powerful, affordable, personal workstations for scientists and engineers. And it was going to build them from off-the-shelf parts and use a powerful OS with available source code—Berkeley Unix. Early on, Sun realized the importance of built-in networking. And its SPARC architecture is one of the most successful RISC designs in history. Although it has seen competition from high-end PCs, Sun has responded by steadily pushing down the costs of its workstations. It must be doing something right. Today, Sun controls at least a third of the workstation market, and its systems are finding lots of work as Internet servers.

■ Tandy

Tandy was one of the three companies to ship a ready-to-run personal computer in 1977 (along with Apple and Commodore). The TRS-80 came with a monitor and

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PC MAGAZINE EDITORS' CHOICE
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Circle 278 on Inquiry Card (RESELLERS: 279).



Most Important Companies

Microsoft BASIC, so you could start programming right away. Tandy's large retail network helped establish personal computers as products you could buy anywhere. All you had to do was walk into one of the 3000 Radio Shack stores with $600 in hand. Although some of the company's executives couldn't see it, true believers at Tandy knew that computers were most powerful when in the hands of individuals. The TRS-80 was one of the seeds that grew into the PC industry. The little wonder known as the Model 100 could be safely described as one of the first laptops. By building low-cost machines, and with help from its enthusiastic, gospel-spreading users, Tandy helped popularize microcomputing.

■ WordPerfect

OK, so it doesn't score well on the Vision-O-Meter. Four years after Michael Shrayer invented Electric Pencil, the first word processor for micros, and a year after Seymour Rubinstein came out with WordStar for the PC, WordPerfect (then called Satellite Software) was working on a word processor for Data General machines. When the company woke up to the personal computing phenomenon, it apparently didn't sleep again for years—too busy bringing out new versions for multiple platforms and grabbing market share in a crowded market. WordPerfect grew to be the world's dominant word processor, with an impressive user base estimated at 5 million.

■ Xerox PARC

This place ought to be called Brainiac City. Xerox's PARC (Palo Alto Research Center) has been home to some of the most brilliant scientists and idea generators in computing. Many products we take for granted today started out as concepts in the mind of a PARC scientist— e.g., the graphical interface, networking, the book-size computer, bit-mapped displays, and visually oriented programming languages. Today, PARC continues exploring new ways of using and operating computers as well as experimenting with very-high-resolution screens, environments that imitate physical space, and user interfaces radically different from the PARC-bred point-and-click approach.



Circle 263 on Inquiry Card.



Top 20 Technologies

California garages again store cars and junk, not computer research labs as they did in the halcyon days of Woz and Jobs. Today, the myths may be tamer, but the pace of innovation hasn't changed. Here are the major technologies of the past 20 years.

■ Microkernel OSes

Proprietary OSes and closed hardware platforms were the reality when the goal was heterogeneous computing. Microkernel OSes burst these constraints with modern, modular OS cores that helped developers build applications faster and port software to a range of hosts without taking a performance hit. Programmers can build new functions into a system by mixing and matching code modules at run time. NextStep introduced these ideas to the commercial world with its Mach-kernel variation, which controlled memory and process management as well as interprocess communications. Carnegie Mellon University's Mach 3.0 now provides the underpinnings for IBM, the OSF, and Taligent's OS development. Microsoft's NT also borrows from the microkernel approach for smoother porting to Intel, Mips, and Alpha-based systems. Similarly, Apple's upcoming Copland release coalesces around a compact microkernel.

■ Structured Query Language (SQL)

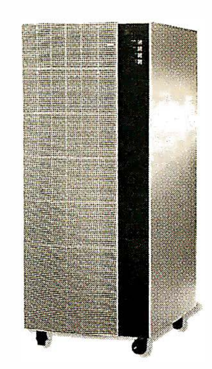
How can telemarketers be sure they'll find your number the minute the dinner hour strikes? SQL is one essential tool, thanks to its ability to handle sets of data. SQL provided a way for interacting with relational databases, and it works with standard programming languages. For years, the burden for database management fell on individual users, until 1969, when E. F. Codd, then at IBM, developed his relational theory of data, which addressed data structure, integrity, and manipulation. However, it wasn't until the mid-1970s that elements of his theories gained industry acceptance via SQL in Oracle and DB2.

■ Ethernet

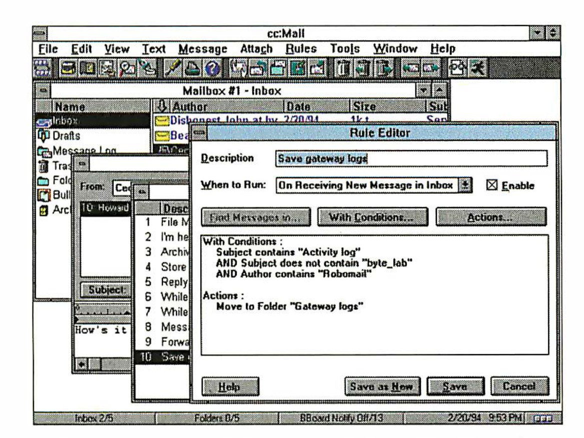
We were so busy joking about when the Year of the LAN would finally come that we didn't realize when it had already happened. The key? Fast, easy-to-install Ethernet networks. Ethernet was visionary because it defined a network capable of 10-Mbps data rates before we needed that speed. Defined by Dr. Robert Metcalfe at Xerox PARC (Palo Alto Research Center), it took the combined efforts of Xerox, DEC, and Intel to turn Ethernet into a commercially viable standard. The version 1.0 specification arrived in September 1980. Two years later, version 2.0 addressed problems related to large networks, reliability, cost, and other issues. Changes to the specification included electrical signaling, cable types, connectors, packet formats, CSMA/CD and back-off algorithms, CRC (cyclic-redundancy check) calculation, and system timing.



PEOPLE CAN'T MEMORIZE COMPUTER INDUSTRY ACRONYMS.



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YOU CAN BEND IT, SPINDLE IT, AND EVEN MUTILATE IT BY APPLYING RULES AND TRIGGERS. IT'S E-MAIL, THE EPISTOLARY TOOL FOR THE 1990S.



Top 20 Technologies

List #10. Predictions for the Year 2000

On the "Killer App"

"A 'killer app' that takes over all of computerdom no longer exists, because computerdom is so big that even a large thing like the Web is still such a small piece...I think a killer application [today] is usually defined as something that takes a new configuration of hardware and makes it viable."

—Dan Bricklin, VisiCalc inventor

On Mobile Computing

"Mobile wireless computers are like mobile pipeless bathrooms—portapotties. They will be common on vehicles, construction sites, and rock concerts. My advice is to wire up your home and stay there. Use information highways to let you stay home with your kids, not to make you more of a road warrior."

—Bob Metcalfe, inventor of Ethernet

On Programming

"I've never been too good at predicting the future, but I can tell you what I wish would happen. I want software tools to become more literate and readable by people other than the programmer...I hope there will be a Pulitzer prize for the best writing of a computer program...There may be new tools to help nonprofessional programmers write programs, but programming is never going to be simple."

—Donald Knuth, TeX inventor

On Voice Recognition

"I believe that voice recognition will become more important in the future but only for trivial functions. The problem is that spoken English is terribly imprecise, even when used by experts...I cannot imagine a more efficient interface for complicated tasks than a combination of mouse pointing and a standard keyboard."

—Thomas Kurtz, BASIC inventor

On Wishful Thinking

Q: If you could get in the time machine and go back and change one thing that's happened in the history of computing, what would it be? A: "I would have written a BASIC interpreter for the first PCs."

—Bob Metcalfe, inventor of Ethernet

On PDAs

In five years, PDAs will become a useful product because of the rapid increase in processing power, their ability to handle cross-platform data, and the communications infrastructure that will be in place.

—David Nagel, Apple

On "Intelligent Agents"

"The computer as intelligent agent is not in our future; we haven't even achieved a Congress of intelligent agents after 200 years of trying. Instead, the computer for the twenty-first century will be the computer that stays out of your way, gets out of your desktop and into your clothing, connects you with people instead of with itself."

—Mark Weiser, Xerox PARC

On Computer Interfaces

"The new things will be highly related to communication...Anthropomorphic-type appearances on-screen that are appealing, engaging."

—Bill Gates, Microsoft

"We'll continue to see some ill-fated attempts, like Microsoft's Bob and the Japanese Friend 2000 project, to animate the computer."

—Mark Weiser, Xerox PARC

"The PC operating systems are not going to be innovative ground for user interfaces. If you look at a lot of the CD-ROM products, they don't use the PC's user interface, they just make up their own. So maybe that's going to be some of the ground for the advances."

—Steven Jobs, Next

On Schools

"I think we are going to expand a lot beginning with the schools that are more up on things, more the leaders. The keyboarding classes are going to [become...] classes that really teach about the guts of the computer...I think [we'll see] topics in schools teaching...how to use it...[and] how to get from one place to another."

—Steve Wozniak, inventor, lots of stuff



Ethernet defined physical media and connections as well as how data, described as frames, is transferred across a LAN. (Very slight differences in how frames are defined separate the official IEEE 802.3 specification from the de facto Ethernet standard.)

■ Client/Server Networks

It's the tie that binds our desktop computers to the processing power, data, and resources of entire organizations. The architecture is the foundation for keeping a business running even if one component crashes. Client/server computing is also the means for technical democratization: We can choose the hardware and software that's best for us rather than declaring allegiances to a particular vendor. Without it, the mobile workers would remain a step behind office-bound comrades in having access to company resources; collaborative workgroups would still be defined by geographical proximity.

■ DSPs

What makes an application really sing? Lurking somewhere under the covers of audio, video, voice, and other multimedia applications are DSPs (digital signal processors). Modern versions of this venerable technology benefit from new chips and multitasking software that let DSPs simultaneously handle two or more processes.

Top 20 Technologies

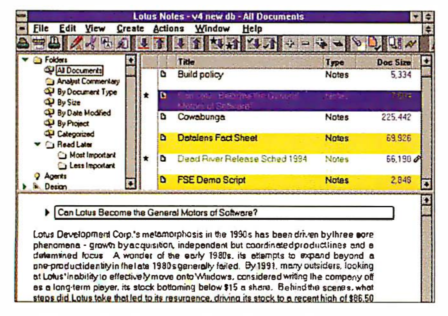
Evolving standards will make DSP application development easier, while general-purpose OSes, including Windows 95, are expected to include DSP programming interfaces, which could push DSPs further into traditional markets. In the future, digital hard drives will likely rely on DSP-powered drive controllers to process signals from the disk.

■ Floppy Disks

Like the proverbial 2-cent bolt that can ground a 767, how could we have worked without the lowly floppy disk? It has given us an inexpensive way to distribute applications and data. Floppies also gave unconnected workgroups "sneakernets," inelegant but essential hacks in the pre-networked world. The Internet, WANs, and CD-ROMs may be cutting into the floppy's territory. And the world probably already has enough floppies in circulation—we just need to reformat all the disks stashed in desk drawers and file cabinets. But before you think floppies are obsolete, break the shrinkwrap on Microsoft's Office Professional 4.3: The collection of programs is still available on 31 disks.

Faster Faster

ETHERNET, DISK DRIVES, MICROPROCESSORS, RAPID APPLICATION DEVELOPMENT



The mind of the corporation, the soul of reengineering: Groupware.

■ Software Components

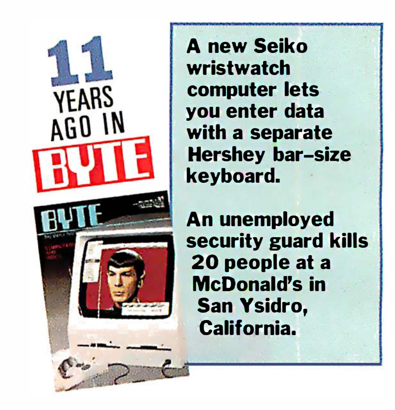
How do you implement custom applications quickly and not bust your operations budget? Plug in a component—those reusable, binary software objects that extend OSes by addressing specific needs. For Windows and the Mac, there are already OCXes (OLE controls); and components are also reshaping the various implementations of Unix and OS/2.

■ The Mouse

Like God and Man touching fingertips in Michelangelo's *Creation*, no other peripheral has done more to symbolically link computers with our humanness. Forget touch-typing or even hunt and peck; the mouse provided a way for computers to become accessible for millions of people. The original design dates back to the Stanford Research Institute and Douglas Engelbart's 1963 wooden prototype. In 1982, Mouse Systems introduced the first commercial mouse (a three-button design) for the IBM PC. The Apple mouse, originally for the Lisa, and Microsoft's mouse, with two buttons, came a year later. Today, the basic structure of interacting with our computers, whether Macintosh, Windows, or Unix, hinges on the mechanical or optical strains of this peripheral.

■ GUIs

The second component in humanizing how we interact with computers, modern GUIs trace their roots to PARC (Palo Alto Research Center) research and the Xerox Star. GUI features introduced successfully in 1984 with Apple's Macintosh (e.g., windows, point-and-shoot menus, program and file icons, dialog boxes, and other now-familiar elements) let us manage our electronic desktops to suit our individual desires.



■ Hard Drives

The peripheral that taught us that too much is never enough. The fixed disk drive became a staple of microcomputers, thanks to its fast data access and transfer speeds. The technology never stood still. We're now getting gigabytes of storage space in petite form factors. In recent years, hard drives have increased data densities at an annual rate of about 60 percent. Magneto-resistive heads are leading the next charge by providing greater areal density than thin film or ferrite-inductive heads. Lower seek times, caching optimizations, and higher spin rates push performance even more. In the future, the digital read channel may double the amount of information we can jam onto drive platters.

■ Laser Printers

These fast, trusty machines have done more to impede the paperless office than any other peripheral. Once laser beams began to transfer images into toner on a

But what about tomorrow?

Ask Windows users where they want to go today, and their answer is likely to be this: Windows 95. It is, after all, a major advance in the state of Windows computing. And it does, finally, bring some of the innovations pioneered by Apple in 1984 to the PC desktop of 1995.

While other PC manufacturers are still struggling to get CDs to load, Macintosh users can create their own multimedia, work in 3-D, surf the Internet and see what's real about virtual reality. Today.

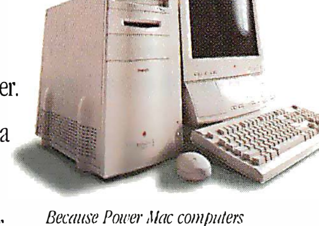
That's great, today. But where, one has to ask, is desktop computing going tomorrow? And is moving to Windows 95 really the right way to get there?

The future of computing.

In a word, it's multimedia. Microsoft and Intel say it's the future. So do we. The difference is, we deliver that future today. To see what we mean, simply turn a Power Mac™ on. When you do, you can not only get down to work (or play) with the CD-ROM of your choice, you can also start using 3-D graphics. You can talk to your Mac.™ And have it recognize your command. You can videoconference across continents. You can even dive into virtual reality.* All at the touch of a few keys and the click of a mouse.

The power to do it.

To do all this, you need power. And the best way to get it is with a Power Mac. In recent tests, for example, the RISC-based Power Macintosh™ 9500 outperformed a 120 MHz Pentium-processor-based PC by 63% on average. When running scientific and technical apps, the performance advantage jumped to 80%. And for graphics, the Power Mac was more than twice as fast.**



Because Power Mac computers are based on the blistering fast PowerPC™ RISC chip, they have power to spare for tomorrow's advanced applications like interactive media and virtual reality.

Eleven years after it was first introduced, Macintosh is still the only personal computer in the world designed from the start as a seamless integration of hardware and software.

The easiest way to get there.

Of course, all the raw power in the world is worthless if you can't use it. That's why every new Mac includes an innovative help system that doesn't just answer your questions, but shows you what to do, where to click and what to type to get things done. And why we make it so easy to create Internet connections, install new software and set up entire new networks from scratch.

More choices than ever.

Today, every new Macintosh® can read and write DOS and Windows disks. But our compatibility goes further than that. The Power Macintosh 6100/66 DOS Compatible, for example, runs thousands of DOS and Windows applications, in addition to thousands of programs for Macintosh. And our new Power Mac systems accept standard PCI cards.

The Power Macintosh 6100/66 DOS Compatible includes both a 66 MHz 486 chip and a RISC-based PowerPC chip, making it the most compatible computer you can find.

In the future, Apple innovations will further break down the barriers between cross-platform collaboration. Distinctions between the platforms themselves will diminish. Even the boundaries between applications will blur.

All of which will add up, once again, to the most important kind of power of all. The power to be your best.®

To learn more about Macintosh power today, and tomorrow, visit us on the Internet today at http://www.apple.com.



*Some of these capabilities may require the purchase of additional software or hardware. **Don't believe us? Surf on over to http://www.apple.com to see the results of independent testing by Competitive Assessment Services, 1995. All Macintosh computers are designed to be accessible to individuals with disability.



Top 20 Technologies

List #11
20 Worst Acronyms

A survey reveals the alphabetic combinations BYTE readers dread most. By far the most disliked is PCMCIA.

ATM
Best guess: High-speed communications technology, Adobe Type Manager, or cash dispenser
Give up? Asynchronous transfer mode

BLOB
Best guess: Cheesy sci-fi monster
Give up? Binary large objects

CORBA
Best guess: Rikki Tikki Tavi's serpentine nemesis, spelled sideways
Give up? Common Object Request Broker Architecture

CSMA/CD
Best guess: Befuddlement
Give up? Carrier-sense multiple access/collision detection

FAT
Best guess: Never mind the cheesecake
Give up? File allocation table

FPSNW
Best guess: Notorious savings & loan that went bankrupt
Give up? File and Print Service for NetWare

FTP
Best guess: Gasoline additive
Give up? File transfer protocol

ISV
Best guess: Medical tubing
Give up? Independent software vendor

MIME
Best guess: Street performer–induced desire to flee
Give up? Multipurpose Internet Mail Extensions

OOBE
Best guess: Fear that speaker is about to break into old Roy Orbison novelty tune (i.e., "Oobie Doobie")
Give up? Out-of-box experience

PCMCIA
Best guess: People Can't Memorize Computer Industry Acronyms
Give up? Personal Computer Memory Card International Association, recently reduced to PC Card

RISC
Best guess: Would they name a car The Liability?
Give up? Reduced-instruction-set computer

SCSI
Best guess: The next big thing after grunge
Give up? Small computer system interface

SOHO
Best guess: Favorite spot of werewolves of London
Give up? Small office/home office

SQL
Best guess: Hollywood technique for capitalizing on success
Give up? Structured Query Language

TCP/IP
Best guess: Oh you do, do you?
Give up? Transmission Control Protocol/Internet Protocol

TWAIN
Best guess: Great American writer; things that shall never meet
Give up? Toolkit without an important name

VESA
Best guess: Credit card; traveling papers
Give up? Video Electronics Standards Association

WAIS
Best guess: Pronounced "ways"? "way-is"? "wah-is"?
Give up? Wide Area Information Servers

WYSIWYG
Best guess: Harpo Marx's hairpiece
Give up? What you see is what you get

piece of paper, it became hard to resist producing hard-copy documents with as many fonts as we could lay our hands on. During the 1980s, high prices helped suppress our paper urge: 300-dpi laser printers sold for $3000 and up, while 600-dpi lasers started at $18,000 before going out of sight. Even so, the printers helped fuel new applications like desktop publishing. Now, 300 dpi is under $1000.

■ LCDs

The feather weight, sleekness, and low power consumption of LCDs made mobile computing practical. As the technology advanced from the netherworld look of passive matrix to dual-scan and large-production-run active-matrix, we were able to travel with the same GUI-based applications we enjoyed on our desktop instead of packing stripped-down applications.

■ Software Agents

Finding data, organizing our schedules, teaching us to use new software applications, planning our vacations—software agents deliver what we've always wanted:

Worst Repeat Offenders

"The acronyms in most CS, IT, and MIS want ads. I have a master's degree in CS and still can't read these ads."
—software engineer in Bozeman, MT

The telecomm and networking folks, who've given us such doozies as DFWMAC (distributed foundation wireless media access control), MESI (modified, exclusive, shared, invalid), and USART (universal synchronous/asynchronous receiver/transmitter)

Performance indicators, like SPECint92

World Wide Web addresses—http://www.etc.etc.etc./better.not.make.a.typo

The Really Stretching It Award goes to VERONICA (very easy rodent-oriented netwide index to computerized archives)

Top 20 Technologies

an electronic guardian angel. These small but smart programs travel into the world to interact, extract information, or deliver data and messages to other systems. The promise is to get work done or to react to fast changes in our business lives while we're off doing other things. However, security fears of these "good" viruses need resolution by the Safe-TCL (First Virtual Holdings) and Telescript (General Magic) developers of the world.

■ E-Mail

Jimmy Stewart in *The Philadelphia Story* called alcohol "the great leveler." The same could be said about E-mail. E-mail has become more than a mechanism for communication: It's given our ideas a forum for being presented to anyone in the organization, regardless of official chains of command. The Postal Service may go out of business.

■ Groupware

Work smarter. Collaborate. Meld the right people on a project-by-project basis. Break down the barriers among departments. Lotus Notes has been carrying this mantle since the late 1980s, and the payoff may be near, evidenced by the rising list of competitors. Groupware helps us tackle unstructured data in the form of text files, graphics, faxes, and E-mail that form the essence of our businesses. Once this data is organized into cohesive units, groupware helps us move the information throughout organizations and provides a way for us to find it and pass it around quickly.



■ CD-ROMs

Turns out that the sum total of our business and cultural knowledge can be served up quite handily in 600-MB chunks. CD-ROMs have made video, audio, and text more accessible by letting us search for and randomly access information quickly and accurately. They have also become the medium of choice for companies needing to distribute proprietary information as well as service and training manuals.

■ PC Card (PCMCIA)

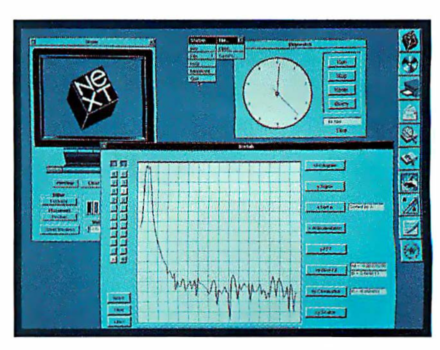
This technology survives in spite of itself. PC Card turns portables into customizable computing platforms that quickly connect to LANs, send and receive data files and faxes, and store information sensitive enough to require nighttime lock up. Developed by Neil Chandra for the Poquet computer, PC Card has grown to encompass much more than its original job as a memory card. However, diversity begat conflicts among cards, hardware platforms, OSes, applications, and driver software. Card and Socket Services has helped smooth out incompatibilities, and the latest incarnations of PC Card include support for a 32-bit data path, bus mastering, and 3.3-V operation.

■ Visual Programming

Visual programming levels the elite and arcane aspects of programming to give tools for applications development, prototyping, and solving particular problems to a broader audience. HyperCard popularized the notion of visual prototyping and laid the groundwork for Visual Basic and Visual C++. Digitalk's Parts, PowerSoft's PowerBuilder, Oracle's PowerObjects, and Meta Software's Design/CPN are other descendants.

■ Parallel Processing

With the capability to perform a variety of operations simultaneously, parallel processing gives new punch to database servers and the evolving computational servers. Shared-memory machines pool memory resources so that each CPU dips from the same pool. This limits scalability, but systems built on this model can run software intended for single-processor PCs. They also use standard CPUs and OSes like NT and Unix. Message-passing systems retain private memory reserves and form the basis for massively parallel supercomputers. The result: superhigh performance for pennies.



WHERE WILL THE INNOVATIONS STOP? NEXT COMPUTER NOT ONLY MADE UNIX PALATABLE, IT BUILT A UNIX BASED ON THE MACH MICROKERNEL ARCHITECTURE. TOO BAD IT DIDN'T SELL.

■ Caching

New generations of CPUs grab the headlines, but MIPS alone won't make our applications run faster. By maximizing throughput from the CPU to system memory, memory caching helps memory chips keep pace with the needs of processors. Similarly, disk caching circumvents roadblocks between the CPU and slovenly hard and floppy drives by using a portion of system memory, in case chunks of data needed in the recent past are needed again. Slower CD-ROMs accrue similar performance benefits. Today, many types of CPUs have their own internal cache to squirrel away information important to the processor.

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- 6-bay desktop case
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- MS Works Multimedia CD

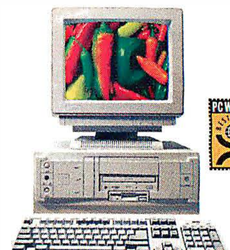
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- 15" SVGA color monitor
- 6-bay desktop case
- MS-DOS 6.2, Windows for Workgroups, Microsoft Mouse
- MS Works Multimedia CD



Pantera™ Pentium™ Processor

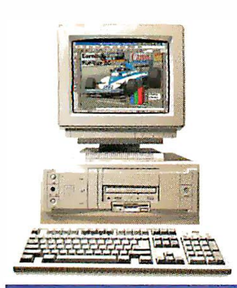
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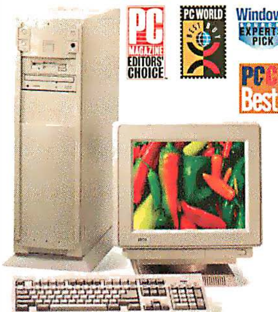
*Orders must be for Computers Now! configurations; we've listed just a sampling here. Since we continuously update this list of configurations, *please call to confirm your system is on the list.* This offer is good only as long as these pre-built systems remain in stock. Monitor upgrades available as long as monitors remain in stock. Other ZEOS systems and configurations take slightly longer—about a week. Credit cards are subject to authorization. Orders must be received by 1 p.m. Central Time, M-F.



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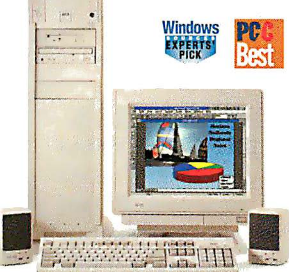
- 16MB EDO RAM, 256K synchronous SRAM cache
- 1GB local bus EIDE hard drive
- 4X CD-ROM drive, 3.5" 1.44MB floppy drive
- Diamond Stealth 64 Video PCI local bus graphics card with 2MB VRAM
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- 15" SVGA color monitor
- 6-bay desktop case
- MS-DOS 6.2, Windows for Workgroups, Microsoft Mouse
- MS Office Pro and Bookshelf CD



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100 MHz
$3195
133 MHz
$3545

Best MM:

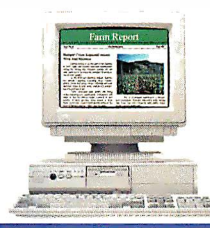
- 16MB EDO RAM, 256K synchronous SRAM cache
- 850MB local bus EIDE hard drive
- 4X CD-ROM drive, 3.5" 1.44MB floppy drive
- Sound Blaster 16® stereo sound card and speakers
- Diamond Stealth 64 Video PCI local bus graphics card with 2MB VRAM
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- Diamond Stealth 64 Video PCI local bus graphics card with 2MB VRAM
- 17" SVGA color monitor
- 10-bay vertical case
- MS-DOS 6.2, Windows for Workgroups, Microsoft Mouse
- MS Office Pro and Bookshelf CD



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$1345

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- 14" SVGA color monitor
- 4-bay desktop case
- MS-DOS 6.2, Windows for Workgroups, Microsoft Mouse
- MS Works



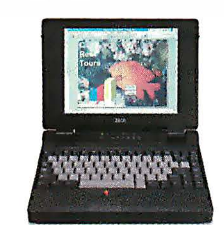
WINDOWS 1995 WIN 100

Meridian™ 400C
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Package #3:

- 8MB RAM
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- 14.4 PCMCIA fax/modem
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- MS Works
- 7.8" x 10.2" x 1.7"; 3.9 lbs.

For active matrix display, add $700



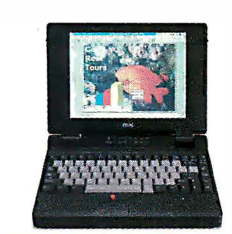
WINDOWS 1995 WIN 100

Meridian™ 800C
DX4-100
$2995

Package #3:

- 8MB RAM
- 528MB IDE hard drive
- Internal 3.5" 1.44MB floppy drive
- 14.4 PCMCIA fax/modem
- 10.3" dual-scan color VGA display
- Custom nylon carrying case
- Extra battery
- MS-DOS 6.2, Windows for Workgroups
- MS Works
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- Extra battery
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July 1994

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A Brief History of Programming Languages

We've come a long way from computers programmed with wires and punch cards. Maybe not as far as some would like, though. Here are the innovations in programming.

ca. 1946

Konrad Zuse, a German engineer working alone while hiding out in the Bavarian Alps, develops Plankalkül. He applies the language to, among other things, chess.

1949

Short Code, the first computer language actually used on an electronic computing device, appears. It is, however, a "hand-compiled" language.

1951

Grace Hopper, working for Remington Rand, begins design work on the first widely known compiler, named A-0. When the language is released by Rand in 1957, it is called MATH-MATIC.

1952

Alick E. Glennie, in his spare time at the University of Manchester, devises a programming system called AUTOCODE, a rudimentary compiler.

1957

FORTRAN—mathematical FORmula TRANslating system—appears. Heading the team is John Backus, who goes on to contribute to the development of ALGOL and the well-known syntax-specification system known as BNF.

1958

FORTRAN II appears, able to handle subroutines and links to assembly language.

John McCarthy at M.I.T. begins work on LISP—LISt Processing.

The original specification for ALGOL appears. The specification does not describe how data will be input or output; that is left to the individual implementations.

1959

LISP 1.5 appears.

COBOL is created by the Conference on Data Systems and Languages (CODASYL).

1960

ALGOL 60, the first block-structured language, appears. This is the root of the family tree that will ultimately produce the likes of Pascal. ALGOL goes on to become the most popular language in Europe in the mid- to late-1960s.

Sometime in the early 1960s, Kenneth Iverson begins work on the language that will become APL—A Programming Language. It uses a specialized character set that, for proper use, requires APL-compatible I/O devices.

1962

APL is documented in Iverson's book, *A Programming Language*.

FORTRAN IV appears.

Work begins on the sure-fire winner of the "clever acronym" award, SNOBOL—StriNg-Oriented symBOlic Language. It will spawn other clever acronyms: FASBOL, a SNOBOL compiler (in 1971), and SPITBOL—SPeedy ImplemenTation of snoBOL—also in 1971.

1963

ALGOL 60 is revised.

Work begins on PL/1.

1964

APL\360 is implemented.

At Dartmouth University, professors John G. Kemeny and Thomas E. Kurtz invent BASIC. The first implementation is a compiler. The first BASIC program runs at about 4:00 a.m. on May 1, 1964.

PL/1 is released.

1965

SNOBOL3 appears.

1966

FORTRAN 66 appears.

LISP 2 appears.

Work begins on LOGO at Bolt, Beranek, & Newman. The team is headed by Wally Fuerzeig and includes Seymour Papert. LOGO is best known for its "turtle graphics."

1967

SNOBOL4, a much-enhanced SNOBOL, appears.

1968

ALGOL 68, a monster compared to ALGOL 60, appears. Some members of the specifications committee—including C.A.R. Hoare and Niklaus Wirth—protest its approval. ALGOL 68 proves difficult to implement.

ALTRAN, a FORTRAN variant, appears.

COBOL is officially defined by ANSI.

Niklaus Wirth begins work on Pascal.

1969

500 people attend an APL conference at IBM's headquarters in Armonk, New York. The demands for APL's distribution are so great that the event is later referred to as "The March on Armonk."

1970

Sometime in the early 1970s, Charles Moore writes the first significant programs in his new language, Forth.

Work on Prolog begins about this time.

Also sometime in the early 1970s, work on Smalltalk begins at Xerox PARC, led by Alan Kay. Early versions will include Smalltalk-72, Smalltalk-74, and Smalltalk-76.

An implementation of Pascal appears on a CDC 6000-series computer.

Icon, a descendant of SNOBOL4, appears.

1972

The manuscript for Konrad Zuse's Plankalkül (see 1946) is finally published.

Dennis Ritchie produces C. The definitive reference manual for it will not appear until 1974.

The first implementation of Prolog—by Alain Colmerauer and Phillip Roussel—appears.



"IT'S BETTER TO ASK FORGIVENESS THAN IT IS TO GET PERMISSION."—THE LATE REAR ADMIRAL GRACE HOPPER, WHO LED THE EFFORT TO CREATE COBOL



A Brief History of Programming Languages



1974

Another ANSI specification for COBOL appears.

1975

Tiny BASIC by Bob Albrecht and Dennis Allison (implementation by Dick Whipple and John Arnold) runs on a microcomputer in 2 KB of RAM. A 4-KB machine is sizable, which left 2 KB available for the program.

Bill Gates and Paul Allen write a version of BASIC that they sell to MITS (Micro Instrumentation and Telemetry Systems) on a per-copy royalty basis. MITS is producing the Altair, an 8080-based microcomputer.

Scheme, a LISP dialect by G.L. Steele and G.J. Sussman, appears.

Pascal User Manual and Report, by Jensen and Wirth, is published. Still considered by many to be the definitive reference on Pascal.

B.W. Kerninghan describes RATFOR—RATional FORTRAN. It is a preprocessor that allows C-like control structures in FORTRAN. RATFOR is used in Kernighan and Plauger's "Software Tools," which appears in 1976.

1976

Design System Language, considered to be a forerunner of PostScript, appears.

1977

The ANSI standard for MUMPS—Massachusetts General Hospital Utility Multi-Programming System—appears. Used originally to handle medical records, MUMPS recognizes only a string data-type. Later renamed M.

The design competition that will produce Ada begins. Honeywell Bull's team, led by Jean Ichbiah, will win the competition.

Kim Harris and others set up FIG, the FORTH interest group. They develop FIG-FORTH, which they sell for around $20.

Sometime in the late 1970s, Kenneth Bowles produces UCSD Pascal, which makes Pascal available on PDP-11 and Z80-based computers.

Niklaus Wirth begins work on Modula, forerunner of Modula-2 and successor to Pascal.

1978

AWK—a text-processing language named after the designers, Aho, Weinberger, and Kernighan—appears.

The ANSI standard for FORTRAN 77 appears.

1980

Smalltalk-80 appears.

Modula-2 appears.

Franz LISP appears.

Bjarne Stroustrup develops a set of languages—collectively referred to as "C With Classes"—that serve as the breeding ground for C++.

1981

Effort begins on a common dialect of LISP, referred to as Common LISP.

Japan begins the Fifth Generation Computer System project. The primary language is Prolog.

1982

ISO Pascal appears.

PostScript appears.

1983

Smalltalk-80: The Language and Its Implementation by Goldberg et al is published.

Ada appears. Its name comes from Lady Augusta Ada Byron, Countess of Lovelace and daughter of the English poet Byron. She has been called the first computer programmer because of her work on Charles Babbage's analytical engine. In 1983, the Department of Defense directs that all new "mission-critical" applications be written in Ada.

In late 1983 and early 1984, Microsoft and Digital Research both release the first C compilers for microcomputers.

In July, the first implementation of C++ appears. The name is coined by Rick Mascitti.

In November, Borland's Turbo Pascal hits the scene like a nuclear blast, thanks to an advertisement in BYTE magazine.

1984

A reference manual for APL2 appears. APL2 is an extension of APL that permits nested arrays.

1985

Forth controls the submersible sled that locates the wreck of the Titanic.

Vanilla SNOBOL4 for microcomputers is released.

Methods, a line-oriented Smalltalk for PCs, is introduced.

1986

Smalltalk/V appears—the first widely available version of Smalltalk for microcomputers.

Apple releases Object Pascal for the Mac.

Borland releases Turbo Prolog.

Charles Duff releases Actor, an object-oriented language for developing Microsoft Windows applications.

Eiffel, another object-oriented language, appears.

C++ appears.

1987

Turbo Pascal version 4.0 is released.

1988

The specification for CLOS—Common LISP Object System—is published.

Niklaus Wirth finishes Oberon, his follow-up to Modula-2.

1989

The ANSI C specification is published.

C++ 2.0 arrives in the form of a draft reference manual. The 2.0 version adds features such as multiple inheritance and pointers to members.

1990

C++ 2.1, detailed in *Annotated C++ Reference Manual* by B. Stroustrup et al, is published. This adds templates and exception-handling features.

FORTRAN 90 includes such new elements as case statements and derived types.

Kenneth Iverson and Roger Hui present J at the APL90 conference.

1991

Visual Basic wins BYTE's Best of Show award at Spring COMDEX.

1992

Dylan—named for Dylan Thomas—an object-oriented language resembling Scheme, is released by Apple.

1993

ANSI releases the X3J4.1 technical report—the first-draft proposal for (*gulp*) object-oriented COBOL. The standard is expected to be finalized in 1997.

1994

Microsoft incorporates Visual Basic for Applications into Excel.

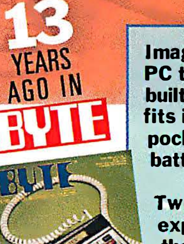
1995

In February, ISO accepts the 1995 revision of the Ada language. Called Ada 95, it includes OOP features and support for real-time systems.

1996

Anticipated release of **first ANSI C++ standard.**

13 YEARS AGO IN BYTE



Imagine a $500 PC that has a built-in modem, fits in your pocket, and is battery powered.

Two British explorers reach the North Pole by way of the South Pole.

WEIRD ERROR MESSAGE NO. 7

>THIS STYLE OF CODE IS NO LONGER USED.

(fashion news from Borland C++)



Notorious Bugs

Bugs in computer hardware and software are no more than the crystallization in silicon and plastic of the mental mistakes all people make. People are only human, after all, so computers can only reflect our own humanity.

■ The Bug That Never Was, Thank Heaven
1983: The SDI (Strategic Defense Initiative) proposal was intended to defend the U.S. against a nuclear missile attack by using computer-aimed weapons to shoot down the missiles. It was estimated that the software would have required some 10 million to 100 million lines of code. Without the Soviet Union's cooperation in staging nuclear missile attacks to test it, the system would have to work perfectly—bug-free—the first time it was ever used. Despite widespread misgivings, a 1986 Department of Defense panel concluded that the concept was still feasible.

■ Check Box to Prepay
1985: An IRS computer error resulted in 27,000 companies receiving warning notices to pay employee federal withholding taxes that they had, in fact, already paid. The House and the Senate planned hearings to investigate.

■ The Bug That Killed
1985–1987: At least four people died when they were exposed to lethal doses of radiation from Therac-25 linear accelerator machines (made by Atomic Energy of Canada Ltd.), used for radiation treatment of cancer. Software errors caused the machines to incorrectly calculate the amount of radiation being delivered to the patient. The most tragic incident to date of death or injuries to human beings due to defective computer software, this incident is a reminder that, as we entrust human lives and health to computers, the seriousness of eliminating bugs becomes a life-or-death proposition.

■ A Bug in a Worm in a Net
1988: A math error caused a "worm" program to multiply 14 times faster than intended, and as a result, the Internet was swamped and overwhelmed in a few hours. It was weeks before affected systems recovered from the damage wrought, costing in the hundreds of millions of dollars. Robert T. Morris, Jr., the Cornell University graduate student who wrote and unleashed the worm, later said, "It was a mistake. I'm sorry."

■ Computer's Down, Check Your Pitons
1988: Backup data, corrupted due to software errors, eventually destroyed all the main system data—and backup copies of data—at an automated Black & Decker distribution center in Northampton, England. Employees were eventually forced to climb the racks of inventory in the unlit warehouse with mountain-climbing equipment to check stock.

■ To Whom It May Concern...
1989: A computer in Paris read files on traffic violations and then mistakenly sent out letters charging 41,000 traffic offenders with crimes including murder, drug trafficking, extortion, and prostitution. Recipients were described as "surprised."

■ Why Doesn't This Ever Happen at Our Bank?
1989: A British bank that understandably wishes to remain nameless mistakenly transferred an extra £2 billion to customers in only 1 hour, when a bug permitted payment orders to be issued twice. Since there was no way to distinguish real from duplicate transactions, the bank had to depend on the honesty of its customers to recover the extra payments.



Notorious Bugs

■ Dial B for Bug
1990: A logic error in its call-handling computers shut down AT&T's long-distance telephone network for 9 hours, the most severe breakdown in the history of the U.S. telephone system. Some 74 million long-distance and 800-number calls were not completed, bringing phone-dependent businesses—like car, hotel, and airline reservations systems, and credit-card approval services—to a standstill.

■ Sin of Omission
1991: American Patriot missiles were fairly successful. However, the failure of some Patriot missiles to track and destroy Iraqi Scud missiles during the Persian Gulf War may have been due to a software problem of the system. During one such Iraqi missile attack, 28 American soldiers were killed in their barracks in Dhahran, Saudi Arabia.

■ A Better Windows than DOS
1991: With the introduction of Microsoft Windows 3.0, "unrecoverable application error" became a household phrase, soon to be replaced by "general protection fault" in version 3.1 (heralded by the headline "Windows Upgrade Crashes Less Often").

■ Don't Use the Calculator! We Need the Right Answer!
1991: It was revealed in 1994 that the Calculator applet in Microsoft Windows did not display correct answers. Reportedly, it took the Pentium bug brouhaha to motivate Microsoft to admit and fix a bug it may have known about since 1991.

■ You Are Lost and Gone Forever...
1993: An $80 million satellite called Clementine was hopelessly lost in space after a software error caused its thruster rockets to fire continually, consuming all its fuel before its asteroid-rendezvous mission was completed.

■ Double, Double, Toil and Trouble
1993: The DoubleSpace automatic hard disk compression software included in Microsoft MS-DOS 6.0—billed as capable of nearly doubling the effective space on hard drives—corrupted data, was incompatible with certain BIOSes, and crashed programs and networks. Besides which, Microsoft lost a compression patent-infringement suit brought by Stac Electronics, to the tune of over $100 million. (Of course, it later struck a partnership with Stac.) Version 6.2, which cleared up the majority of these problems, was denied to be a "bug fix."

■ Don't Even Leave the Airport
1994: For months, bugs in a computerized baggage-handling system delayed the opening of the new Denver airport. The system would drive automated baggage carts into walls or deposit bags at the wrong airport destination. After an additional expenditure of some $80 million to fix the system, the airport finally opened in February 1995—with a manual baggage-handling system that will be phased out gradually. Sometimes you just can't beat the human touch.

■ Dividing We Fall
1994: The Pentium bug, probably the most widely reported-on bug in history, was a glitch in the lookup table used to perform floating-point division in Intel's flagship chip. The magnitude of errors ranged from 1 out of 10,000 to 1 out of 1 quadrillion, while estimates of the frequency of errors varied widely from days to millennia. Probably more significant than the defect itself was the fact that Intel's reputation was tarnished needlessly: Intel knew about the problem, decided to keep it a secret, and then downplayed the defect when it was discovered independently. It is estimated that Intel may have lost upward of $400 million due to the Pentium bug.

8 YEARS AGO IN BYTE



Steve Ciarcia builds the ultimate infrared remote control device: It controls all your other remotes.

U.S. Surgeon General C. Everett Koop recommends televised condom commercials to fight AIDS.

■ Oh, I Just Can't Wait to Be (Wor)king
1994: Disney Interactive was the cause of some Christmas-morning traumas when its Lion King animated story CD-ROM, easily the most-anticipated and best-selling title during that season, wouldn't work. Inadequate testing by third-party developers caused installation failures on many PC systems. This may have been the first bug to affect popular culture.

■ And on Wall Street, 166 Funds Remain Unchanged
1994: One day, Fidelity Investments, the $250 billion mutual fund corporation, was temporarily unable to calculate the "net asset value" for 166 of its 208 mutual funds because a bug had overwritten every stock in its database with 9s. A low-level employee authorized using the closing prices of the previous day rather than admitting that Fidelity didn't know what the actual prices were. The subsequent uproar resulted in the establishment of rules for handling such situations in the future.

■ The Incredible Growing File
1994: A bug in CorelDraw 5 caused the size of a file to multiply wildly when certain operations were performed, transforming 2-MB files into 30-MB behemoths. Although fixed in subsequent releases, another file size problem later emerged.

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Notorious Bugs

■ Three of Life's Certainties: Death, Taxes—and Bugs
1994–1995: Intuit announced that calculation errors or loss of data could occur in both its TurboTax and MacInTax income tax preparation programs. Many people use such programs because they are worried about making errors by doing their taxes manually. Can you say "irony"?

■ Absolutely, Positively Deleted
1995: Millions of Super Bowl telecast watchers were impressed by ads for Federal Express's new Windows software for handling package pickup and keeping track of FedEx deliveries. Unfortunately for the estimated 15,000 companies that started using the first release, all their records were deleted on the first day of each month.

■ The Bug Is Yet to Be
2000: When the global odometer turns over on January 1, 2000 A.D., computer systems the world over are expected to buckle. Legacy mainframe programs hard-coded to treat the year "00" as 1900 will begin calculating negative ages, seniorities, and benefits. Where will your bet be when the millennial roulette wheel comes up "00"?

List #14
Best Computer Shows

Of late, it seems many trade shows are more about chachkis than products or technologies. But that wasn't always the way...

The Faire Queen

The West Coast Computer Faire earns top honors from those who remember it. One year, it filled (and we mean *filled*) Brooks Convention Center in San Francisco, with booths in the halls and in the chair storage room—and even in the garbage collection area! It was where the first 68000 was shown, where the Lilith was shown, and where little computers got seen by a lot of people who had never paid any attention to them before. So what if its name is spelled funny?

CD Chance

Bill Gates isn't just the head of the largest software company in the world—he's also the father of the CD-ROM Conference. At the time, it seemed a financial risk for him (the richest man in the world), but looking back, it was clearly right.

On the First Comdex

It was a small show. Contributing editor Jerry Pournelle went to it because he could drive to it. He says, "Wasn't much, but it sure kicked things off." By the third Comdex, things were really happening. Now it cripples Las Vegas every fall.

Wescon

Trolley cars, the Golden Gate Bridge, and fog aren't the only things to come out of San Francisco. In the mid-1970s, it was also the place to hear about the latest chips. Among other things, the MOS Technology 6502 (to become the brains of Steve Wozniak's Apple II) was introduced there.

Tell All

The microprocessor field is highly competitive and very secretive. The Microprocessor Forum is a kind of you-show-me-yours-and-I'll-show-you-mine show. If you keep your ears and eyes open, you'll see what every major processor company is planning for the next three to five years. Well, maybe not everything.



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Mac Compatibility	1024x768@75Hz	1024x768@75Hz	1152x870@75Hz
Color Temp. Selection	•	•	•
UltraClear Coating™		•	•
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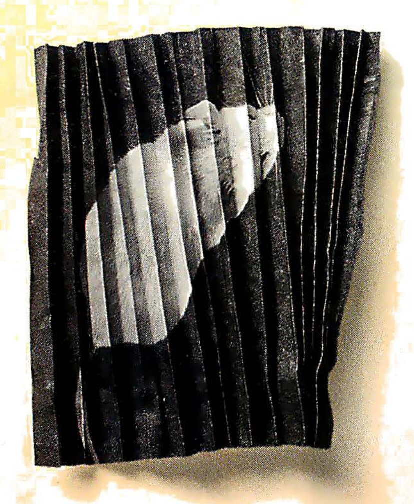


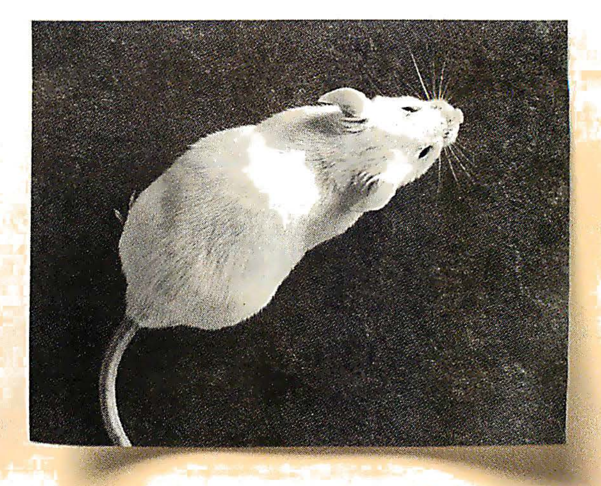


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20 Contributions To Society

Computers have changed our world. That's a tired cliché, but it's true. Perhaps no other instrument of the late twentieth century has had such a fundamental and pervasive impact on our everyday lives.

Astronomy
The Hubble Space Telescope is now fixed. But astronomers were able to salvage useful images from it even before the Space Shuttle's repair mission. Image-processing software let them extract clear images from the fuzzy ones sent down by the Hubble camera.

Aviation
The Boeing 777 is the first of a new generation of airframes. It was designed entirely on computers, never going through mock-ups and prototypes. It represents the natural culmination of the trend toward CAD.

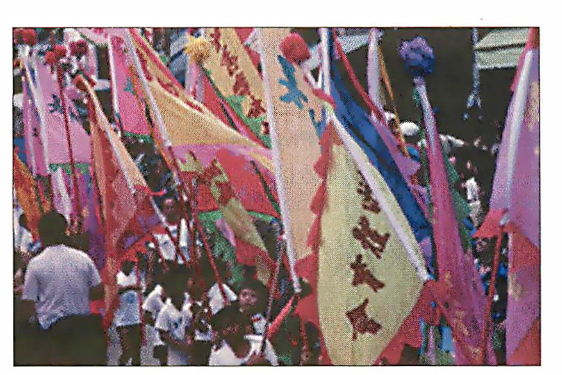
Biology
The Human Genome Project, an ambitious multiyear effort to map the human genetic code, would be impossible without computers to store and sort the mountains of data nature has put into the human genetic sequence.

Business
If, as some recent advertisements claim, business is the engine of society, then computers must be the fuel. How else could arbitrageurs force huge swings in stock prices, without computers to show them the point spreads and rapidly execute their trades before the spread closes? And how else could Federal Express track billions of packages, delivering them accurately and on time?

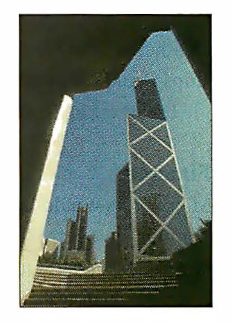
Communities
On-line communities have evolved to meet almost any interest. Whether you want to rail against Barney the dinosaur, compare Captain Janeway to Captains Picard and Kirk, or trade meatloaf recipes, there is a virtual community for you somewhere. It can be tough sometimes to find those who share your interests, but they are almost surely out there.

Consumers
The relationship between customers and manufacturers has changed. The concept of beta testing was foreign to most of the population 20 years ago. Would anyone have bought an automatic transmission if the manufacturer told you that it occasionally locked up and sometimes rebooted to first gear for no apparent reason? Yet we accept software that way.

Education
The coming of the information age is forcing schools to rethink curricula, which they probably should do anyway. Unfortunately, some schools insist on using computers as glorified flash cards, transferring boring rote learning from paper to software. And some of the glitzy multimedia education tools go too far the other way, making education into a game. Somewhere in between are schools using computers to let kids run



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20 Contributions To Society

experiments, analyze data, and write papers in ways that could not have been imagined 20 years ago.

Entertainment

Computers controlled the motion cameras that let George Lucas shoot all the components of a single scene separately—the Death Star, the Tie Fighters, and the Rebel ships—and then composite them into a single breathtaking piece of movie history.

Finance

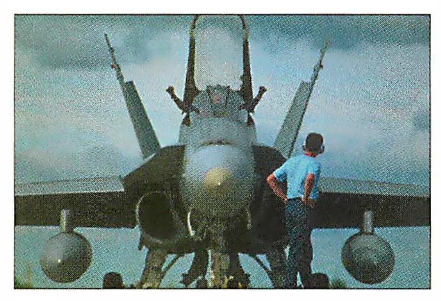
Many of us would be bankrupt paupers without the control over our finances that programs such as Quicken have brought. Even if you don't use the programs yourself, it's likely your accountant does.

Government

Computers have created an industry that provides jobs for thousands of intelligent people who might otherwise be burdens on society—or worse, government bureaucrats. Thank your lucky stars.

Health Care

Computers empower the physically challenged to lead productive lives; the brilliant physicist Stephen W. Hawking is an excellent example. He suffers from the degenerative muscle disease (amyotrophic lateral sclerosis) popularly called Lou Gehrig's disease. Although he cannot use his own voice to speak or his own hands to write, he continues to contribute world-class science.



THE $64,000,000,000 QUESTION: IS THIS AN OPPORTUNITY TO TAKE A CHEAP SHOT AT MILITARY SPENDING?

Manufacturing

Just-in-time manufacturing, which seeks to reduce inventory while increasing responsiveness to changing markets, would not be possible without computers.

Medicine

Noninvasive imaging technologies, such as CAT (computerized axial tomography) scans, have given doctors the ability to perform exploratory surgery without ever opening up the body. Soon, computer software that was originally developed to spot Soviet tanks from satellite photos will join the doctor's arsenal as a way to identify possible cancers in a mammogram.

Meteorology

The percentage of incorrect weather reports has been dropping, due in large part to better weather models. The recently announced vBNS (very high-speed Backbone Network Service) will let several supercomputers work together on much larger simulations, which should further improve the accuracy of forecasts.

Military

As the Gulf War showed us, technical superiority can overwhelm numerical superiority. Getting there first with the most is no longer as important as having the most advanced weapons. Computer-controlled weapons help a small, well-equipped armed force keep the peace in a dangerous world.

Physics

A physicist with some new theories on star formation runs a simulation based on her new theories to test it out. Another seeking the basic quantum particles examines the remains of a proton/antiproton collision, like some voodoo priest examining the entrails of matter rather than the entrails of chickens.

Politics

During his recent unsuccessful run for the U.S. Senate, Oliver North was able to raise millions of dollars from outside his state, using mailing lists of like-minded individuals. A state-level operation never could have handled such a sophisticated, nationwide fund-raising effort without cheap, sophisticated databases.

Publishing

The very definition of a magazine is changing. It is now de rigueur to have a Web page on the Internet's WWW (World Wide Web). Bandwidth for most users is still too narrow to allow fully formatted pages of text and graphics, and there is still too small a percentage of the population on-line. But this is changing.

In the realm of publishing on paper, now anyone with a computer and some imagination can turn out professional publications thanks to the power of desktop publishing.

Travel

Computers have improved the way we travel, from reservation systems that instantly let us book flights anywhere to the early-warning systems that let pilots know of potentially dangerous microburst downdrafts.

Writing

E-mail has at least temporarily stayed the death sentence of writing. Sure, the quality of some E-mail is less than stellar, and the temptation of easy, almost anonymous, flaming has exposed the worst side of human nature. But communicating via E-mail lets us keep in touch with a far-flung network of friends and associates.

Thanks to word processors, the task of writing has gone from chiseling in stone to sculpting from clay. It's so much easier to push and prod your words when they are glowing phosphors on a screen than when they were typed on your old IBM Selectric. We don't always take advantage of this ability, but at least it's there.

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Memory/Chips/Upgrades	15
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Modems/Multiplexors	17
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PCMCIA	57
Printers/Plotters	20
Programmable Hardware	21
RAID Drive Arrays	56
Scanners/OCR/Digitizers	22
Security	52
Tape Drives	23
UPS/Power Management	24
Voice Technology	55

Software

Business	25
CAD/CAM	26
Communications/Networking	27
Data Acquisition	28
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Macintosh	34
Mail Order	35
Mathematical/Statistical	36
Miscellaneous Software	37
On-Line Services	38
Operating Systems	39
OS/2	54
Programming Languages/ Tools	40
SCSI/Peripheral Interfaces	59
Security	41
Shareware	42
Software Duplication	43
Spreadsheets	44
Unix	45
Utilities	46
Windows	47
Word Processing/DTP	48

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Recruitment	50
Miscellaneous	51

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18 [ ] Applications Development
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25 [ ] Windows/NT
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Inquiry Numbers 1–187

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
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154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170
171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187

Inquiry Numbers 188–374

188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204
205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221
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358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374

Inquiry Numbers 375–561

375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391
392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408
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545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561

Inquiry Numbers 562–748

562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578
579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595
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732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748

Inquiry Numbers 749–935

749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765
766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782
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Inquiry Numbers 936–1122

936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952
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Inquiry Numbers 1123–1309

1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139
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1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326
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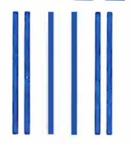
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16 20TH ANNIVERSARY REPORT BYTE

The 20 Most Important People

Although computers are technology, they are created by people. And the people who create them are not just one-dimensional nerds—in fact, their breadth fuels their innovation. These 20 people have made the greatest impact on microcomputing.

■ Dan Bricklin

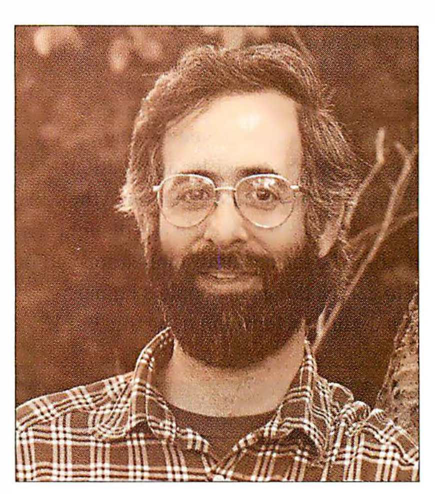
Can you imagine doing business without the spreadsheet? Dan Bricklin can't. But, then, he invented it. He got the idea while sitting in a class at the Harvard Business School. As he watched the professor fill in spreadsheets on the chalkboard, he thought, Wouldn't it be nice if you could do that electronically? Bricklin designed the interface, and his partner, Bob Frankston, wrote most of the code. They released VisiCalc in 1979, an act that fomented the desktop revolution. At last, there was something useful to do on a microcomputer.

Did he know at the time how important spreadsheets would be to computing? "Well, you always believe that your product's going to be wonderful and make major changes, but you can't always depend on that. I thought it would be very useful for business, and I tried to design it to be as useful [in] as many different areas as possible."

What about today's sophisticated spreadsheet features? "For any given user, there are things that are superfluous, and for any given user, there are things that are missing. For my needs, just being able to recalculate is 90 percent of the way there. In that case, almost everything is sufficient."

As important as VisiCalc was, the decision not to seek patent protection helped spawn an entire industry. With a patent, Bricklin could have controlled the market for 17 years. Great for him; lousy for us. "Seeing the advances that did come about from people trying different things and [being] willing to make compromises that we may not have been willing to make, I don't think the industry would have moved as far as it has."

Lotus bought the VisiCalc rights in 1985. Bricklin has gone on to design other successful, though more specialized, products but none has revolutionized computing like the spreadsheet.

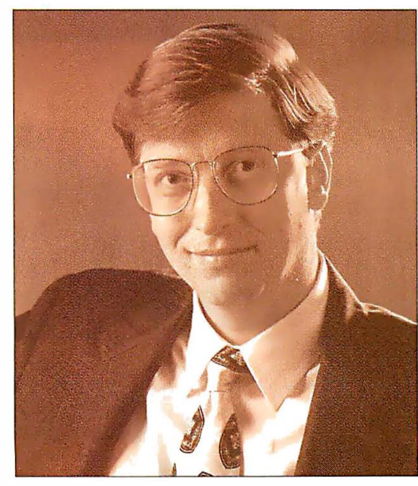


FATHER OF THE SPREADSHEET, DAN BRICKLIN.

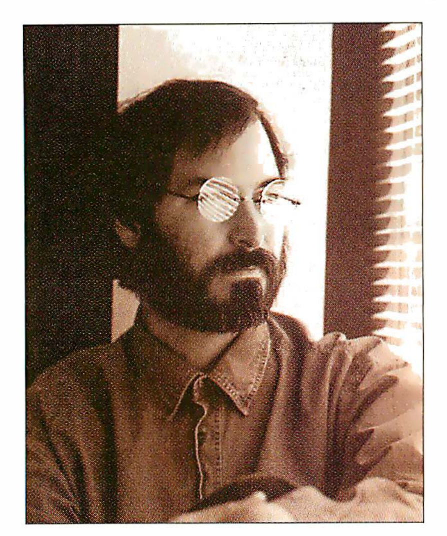
■ Bill Gates

Here's one man who needs no introduction. Back in 1975, Bill Gates and a high school buddy, Paul Allen, wrote a version of BASIC that ran in 4 KB on the MITS Altair 8800 computer. Soon they founded Microsoft and were creating versions of BASIC and other languages for various platforms. Their Big Break came in 1980 when IBM contracted with them to write Disk Operating System, or DOS, for its new PC. Through an incredible act of charity or stupidity, IBM gave Microsoft rights to sell versions of DOS to other manufacturers.

Today, Gates is worth more money than the other 19 people on our list put together (and they include several multimillionaires). But we're here to talk technology, not tax shelters. Gates, who is about to launch Microsoft Network, recalls that he



BILL GATES: YOUR BASIC BILLIONAIRE.



NEXT ON OUR LIST, STEVE JOBS.

and Allen long ago believed on-line services would be the killer application: "We thought they would catch on in the 1970s and the 1980s. We always thought that would be the defining application and it would get the things in people's homes, which definitely turns out to be true but 15 years later than we expected."

Why the delay? "What you can do with 300 baud is tricky... Then there was the small problem of a business model, how to deliver an essentially free service to people and get advertising to pay the freight. Finally, PCs lacked critical mass: Unless you get an immense number of people using it, it's of no value... We were naive to think that would spark a critical mass."

Any final thoughts? "The last big revolution in communications to have this kind of impact was the telephone. It was a two-way device, and it shrunk the world. The world became a different place."

■ Steve Jobs

Unless you've been stuck on a streetcar named Mobius these past 20 years, you know the saga of Steve Jobs: College dropout, garage-shop inventor, cofounder of Apple Computer, ousted in 1985 at age 30, cofounder of Next Computer. During the Apple II's heyday, he stood in the shadow of his partner, the technically superior Steve Wozniak. But his marketing moxie, his love affair with the microphone, and his unrelenting vision for the Macintosh, released in 1984 with a revolutionary GUI, catapulted Jobs beyond the limelight.

As the name brashly implies, Jobs hoped the Next would be the next killer machine. But with an $11,000 price tag, even a high-tech Billy Graham couldn't win many converts. "We knew we'd either be the last hardware company that made it or the first that didn't, and we were the first that didn't." He's repositioned Next and now wants to be the main man in object technology. "I went to Xerox PARC in 1979, and I saw the Alto. There was a crude graphical user interface on it...within 10 minutes it was obvious that all computers would work this way someday. Objects are the same way. Once you understand what objects are, you realize that all software will be written using objects, object technology."

What does this innovator think of today's interfaces? "The Mac has been dead in the water since 1985 in terms of its user interface. And Windows is still a sort of

caricature of the Mac. Windows 95 doesn't really get it. The user interface is not very good."

Never short on bombast, Jobs likens today's GUI situation to TV. "You think it's a conspiracy [by] the networks to put bad shows on TV. But the shows are bad because that's what people want. It's not like Windows users don't have any power. I think they are happy with Windows, and that's an incredibly depressing thought."

■ Robert Noyce

Can you imagine saying Germanium Gulch instead of Silicon Valley? Thank Mother Nature and Robert Noyce for sparing us from that mouth mangler. Here's why.

In late 1958, a young engineer at Texas Instruments named Jack Kilby placed two circuits on a single piece of germanium, hand-wired the interconnects and—presto—created the first IC. Within months, Noyce and company at Fairchild Semiconductor used a planar process they had developed to connect the components on their version of the IC. In so doing, they discovered that the IC's conductivity was better and more controllable when silicon was used instead of germanium. To this day, Kilby and Noyce are both credited as the independent co-inventors of the IC.

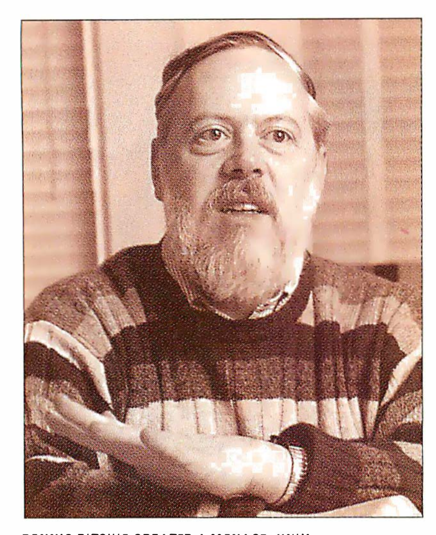
Within three years, Fairchild and TI were producing affordable chips in volume using Noyce's process, a manufacturing technique that has undergone minor improvements but remains basically unchanged to this day. ICs were first used in a commercial product—a hearing aid—in 1963. By the mid-1960s, they were used widely throughout the electronics industry. Noyce went on to cofound Intel Corp. in 1968 and served as president and chairman of the board.

In mid-1988, after the U.S. chip industry had been losing market share to offshore competitors for years, Noyce was named CEO of Sematech. The government-industry consortium was established to conduct advanced computer chip R&D on behalf of its members and to advance U.S. competitiveness. It succeeded. Noyce, the son of an Iowa minister, was widely regarded as a gentleman and a scholar. He died at the relatively young age of 62 in 1990.



ROBERT NOYCE: FIRST NAME IN SILICON.

As an aside, a few years after inventing the IC at Texas Instruments, Kilby helped toll the death knell for the time-honored slide rule when he was a member of the TI team that invented the first pocket calculator. Kilby still works as a consultant.



DENNIS RITCHIE CREATED A MENACE: UNIX.

■ Dennis Ritchie

It took some chicanery to overcome one of the biggest hurdles to the development of Unix. And we're not talking about some kind of sleight-of-hand code writing.

Launched in 1969 as a nonprofit venture between Bell Telephone Labs, General Electric, and MIT, the effort to create an OS for a large computer that would handle up to a thousand simultaneous users was almost scuttled early on for lack of a computer (they were really expensive in those days). Dennis Ritchie and his codevelopers, including Ken Thompson, finally suggested to BTL that it buy a PDP-11/20 for a text-preparation project. BTL regarded text preparation as something useful and spat out the seed money for the $100,000-plus machine.

"There was a scam going on," Ritchie once recalled. "We'd promised [to develop] a word processing system, not an operating system. But by the time the full computer had arrived in the summer of 1970, work was moving at full steam on both." And thus was born Unix. The text-processing system was a success, and the patent department at BTL became the first commercial Unix user in the bargain.

Unix, for which Ritchie deserves much of the credit, was one of the major advances in computing, giving the user features and functions that were previously unthinkable. It was not only a great advance but a great simplification, demonstrating that a relatively small OS could be portable, machine independent, and affordable. The advent of the workstation and the growth of networking have cinched Unix's place in computing. Since the late 1970s, Unix has had a profound impact on DOS, the Mac OS, Windows NT, and many others.

Ritchie and Thompson wrote the first *Unix Programmer's Manual* in 1971. Ritchie developed C, and in the early 1970s, he and Brian Kernighan coauthored *The C Programming Language*. Ritchie, now in his mid-50s, still works at AT&T research labs, where he is developing OSes, including Plan 9 from Bell Labs.

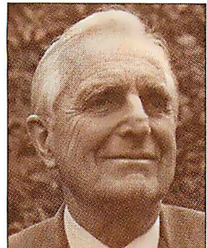
■ Marc Andreessen

Less than two years ago, while his classmates were still nursing graduation hangovers, Marc Andreessen, at the age of 22, cofounded Netscape Communications. The other founder is Dr. James H. Clark, founder and former chairman of Silicon Graphics, Inc. This, the youngest member

of our top 20, is the latest wunderkind to compile. What Steve Jobs was to the desktop, Andreessen is to the Internet. His Netscape Navigator (née Mosaic) for PCs, Macs, and Unix machines already accounts for more than half of all Web browsing. He led the development of the prototype while he was an undergraduate at the University of Illinois. Unlike some of the other wunderkind (whose names we won't mention), Andreessen graduated from college.

■ Bill Atkinson

If you knew the Lisa like Bill Atkinson knew the Lisa, then you knew a lot more about the Lisa than most of us wanted to know. But from this scarlet woman, named for Steve Wozniak's daughter, came a GUI. Atkinson was the chief wizard behind its graphics engine. The Lisa begat the Mac, and the rest is history. Today, as cofounder of Apple spin-off General Magic, Atkinson wants to create technology that he hopes will be welcomed into people's lives, rather than be a source of stress—technology like MagicCap. We also fondly recall that he



DOUG ENGELBART



GRACE MURRAY HOPPER

was the chief designer of HyperCard, the software construction kit that put Mac programming tools into the hands of millions of Mac users.

■ Tim Berners-Lee

If the snobs who whine about the Internet's exploding popularity ever form a vigilante posse, the first man they'll hang is Tim Berners-Lee. He's the guy behind the World Wide Web, which he developed for the CERN (European Council for Nuclear Research) in Geneva, Switzerland, so that physicists could swap data easily. Berners-Lee developed the URL, HTML, and HTTP standards, from which he wove the Web. Since launching the Web in 1991, he has often endorsed the idea of people using it for profitable transactions. He's now at MIT, where he directs the World Wide Web Consortium, which deals with Web security and other issues. He deserves a Nobel prize of some sort.

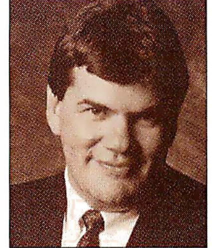
■ Doug Engelbart

Got patent envy? You'll have a hard time matching this pioneer, who holds 20, most of which are on basic features in microcomputing. Imagine microcomputing without windows; or word processing; or hypermedia, E-mail, and groupware; or the Internet. Imagine microcomputing without Doug Engelbart, now 70, who for years was a fixture at Stanford Research Institute. Engelbart had a vision that computers could be more than giant adding machines; they could be tools for human beings. A few years ago, he founded the Bootstrap Institute, dedicated to getting companies to collaborate on innovation. Comparisons with Thomas Edison do not seem

farfetched, which reminds us: He's best known for the first mouse—a wooden rodent invented in 1963.

■ Grace Murray Hopper

As a child, Grace Murray Hopper liked to take apart alarm clocks. She was the first woman to earn a doctorate in math at Yale. In World War II, she joined the Navy and was assigned to its computational center at Harvard. Amazing Grace later developed the first compiler for Remington Rand's UNIVAC in the early 1950s and led the charge to create COBOL. The Navy recalled her in 1967, and she was on active duty until 1986. She died in 1992 at the age of 85 with the rank of rear admiral. Anyone who met her could not help but be awe-struck by this diminutive fire storm of a human being. One pictures her stuck in purgatory, refusing to enter Heaven until St. Peter agrees to computerize. With a Lucky Strike hanging from her lip, she fires at the grand saint: "Beg your pardon, Sir, but your excuse, 'We've always done it this way,' is the most damaging phrase in the language."



PHILIPPE KAHN



DREW MAJOR

■ Philippe Kahn

French swagger, German determination, jazz artistry—must be Philippe Kahn. This software swashbuckler writes great compilers, plays David against Microsoft's Goliath, and never bores us. The son of a German father and a French mother, Kahn grew up in Paris. He studied Pascal with Niklaus Wirth, took a degree in math, earned money playing jazz, and developed applications on an Apple II. But Pascal compilers were too slow, so he wrote Turbo Pascal. Then he marketed it. With only $2000 in his pocket, he landed in the U.S. with no green card and no job. He founded Borland International in an office over an automobile repair shop in 1983. Despite the humble abode, Kahn convinced a BYTE ad salesperson to accept on credit a full-page color ad for Turbo Pascal. At a ridiculous $49.95, Kahn was swamped with orders.

■ Mitch Kapor

"Software has been very, very good to me," Mitch Kapor once said. And, we add, Mitch Kapor has been very, very good to software. In 1982, he founded Lotus Development and, with Jonathan Sachs, created Lotus 1-2-3. Dan Bricklin invented the electronic spreadsheet (VisiCalc), but Kapor turned it into a more powerful, yet friendly, business tool. Lotus 1-2-3 remains the world's most widely used application. Given IBM's takeover of Lotus, it's interesting to note that Kapor once tried and failed to interest Big Blue in an exclusive marketing deal for 1-2-3. He left Lotus in 1986. In 1990, he cofounded the Electronic Frontier Foundation, a nonprofit group dedicated to understanding the social impact of the digital revolution.

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■ Donald Knuth

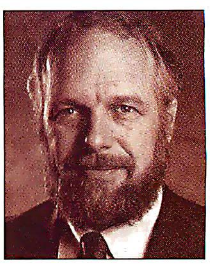
Nearly 20 years ago, while Donald Knuth was proofing galleys for the second edition of the first volume in his *The Art of Programming* magnum opus, it hit him: A book of 0s and 1s doesn't have to be ugly. The result was a 10-year hiatus from his *Art* series to develop TEX, a typesetting language for scientific publishing, and Metafont, an alphabet design system. Then the prolific scholar/programmer knocked out six books to explain them. (Now *there's* a word processor.) Now professor emeritus at Stanford, his fourth *Art* volume of a planned seven is in press. Oh, he's also a biblical scholar, having written *3:16 Bible Texts Illuminated*, a history that examines chapter 3, verse 16 in each of the Bible's 59 books.

■ Thomas Kurtz

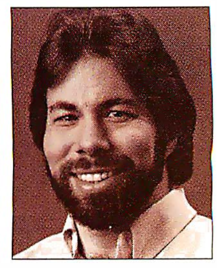
Overkill. That's what Thomas Kurtz thinks of today's software. "The public has been sold the most complicated word processing systems imaginable, when all they want to do is to write a letter." Aching for simplicity in a computer programming language, Kurtz and John Kemeny codeveloped BASIC in 1964. It has its detractors, but BASIC is still bundled on virtually every microcomputer sold. They never copyrighted it, so dozens of variations appeared. This horrified the Drs. K, who dubbed the dialects "Street BASIC." In the 1980s, they formed a company to develop True BASIC, a lean version that meets ANSI and ISO standards. Kurtz is currently a professor emeritus at Dartmouth. Kemeny, once president of Dartmouth, died in 1992.

■ Drew Major

As Drew Major sees it, "In the next [computer] generation, nothing will not be connected." But what would you expect from Major, chief scientist at Novell and lead architect of NetWare, still the preeminent NOS (network OS). Fresh out of Brigham Young University in 1980, Major and two buddies took a six-week consulting job at Novell (which was trying to make CP/M machines) and wound up staying 15 years. When NetWare 3.0 shipped in 1989, it contained server-based applications called NLMs (NetWare loadable modules), a great leap forward over the kludgy VAPs (value-added processes) of the previous version. How bad were VAPs? They're the only thing about NetWare that Major ever apologized for. Undoubtedly, his mother taught him to be polite.



JOHN WARNOCK


STEVE WOZNIAK

■ Robert Metcalfe

For five points, what came first: commercially sold PCs or the LAN? Robert Metcalfe knows. He outlined local networking technology in his doctoral dissertation at Harvard. In 1973, he went to Xerox PARC, where he invented Ethernet to connect the Alto computers (never sold commercially) in use there. Thus, the LAN was born before the first PCs were marketed. Today Ethernet connects more than 50 million computers. In 1979, Metcalfe founded 3Com, a networking company. He retired in 1990 and was publisher of *InfoWorld* for 2½ years. So what does the Father of Ethernet think about the information highway? A fad. "Soon the fad will be over," he says. "Then we can get back to the business of building I-ways—another 50 years of plumbing."

■ Bjarne Stroustrup

Perhaps because their native tongues are not widely spoken, Scandinavians are noted for their multilingual talents. So it's no surprise that C++ inventor Bjarne Stroustrup, a native of Denmark, rejects any notion of a universal programming language: "...the idea of spanning the whole spectrum of programming with one language is absurd." In the mid-1980s, Stroustrup, head of Bell Labs' large-scale programming research department, defined the C++ object-oriented extension of the C language. He also authored two notable works on C++, including *The C++ Programming Language*. To those who whine about how hard C++ is to use, he says: "It wasn't meant to be learned in 2 hours."

■ John Warnock

Two innovations clearly sparked the desktop publishing revolution: The Mac and

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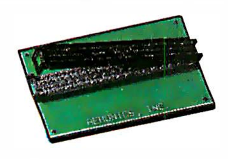
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John Warnock's Postscript PDL (page-description language). Warnock cut his teeth at Xerox PARC, where he developed graphics imaging standards. In 1982, he and his partner, Charles Geschke, founded Adobe Systems to create pioneering software products for desktop publishing and electronic document technology. As millions of computer users begin to wander the information highway, Warnock sees a day when cross-platform document and graphics standards will be a reality. "I think meaningful document standards will emerge over the next five years. There is a need for an abstraction layer that is independent of operating systems."

■ Niklaus Wirth

Pascal begat Modula 2. Modula 2 begat Oberon. And Niklaus Wirth begat them all. Wirth, of the Swiss Federal Institute of Technology, likes to quote Albert Einstein: "Make it as simple as possible but not simpler." Much of today's software is overweight and inefficient. Wirth is showing a simpler way with OOP (object-oriented programming). His latest, Oberon (a language and an OS), lets developers reuse built-in data structures without recompiling the entire OS. Applications are replaced by leaner tools that the OS can access on demand. One result: fewer bugs. Need more proof? The Oberon PC version, including a GUI, uses 1.5 MB of RAM; Microsoft Windows 3.1 needs 4 MB.

■ Steve Wozniak

Consider Steve Wozniak, the Wizard of Woz, the Ultimate Hacker, one of the great garage inventors of all time. With the millions he earned when Apple went public, Woz no longer works like the rest of us. The Father of the Apple II (don't worry, the other Steve gets some credit, but it was Woz's baby) now throws his energy into helping youths learn computers. "I believe more and more we should support the people who are not computer experts." He not only spends hundreds of hours teaching, he also personally picks up the cost of AOL accounts for about 100 kids. "The worst problem isn't so much students, but teachers really need forced training. It costs money. The school board has to sit back and reprioritize what is going to be taught."

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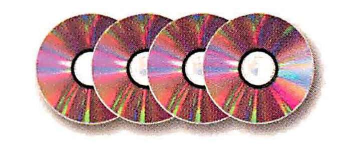
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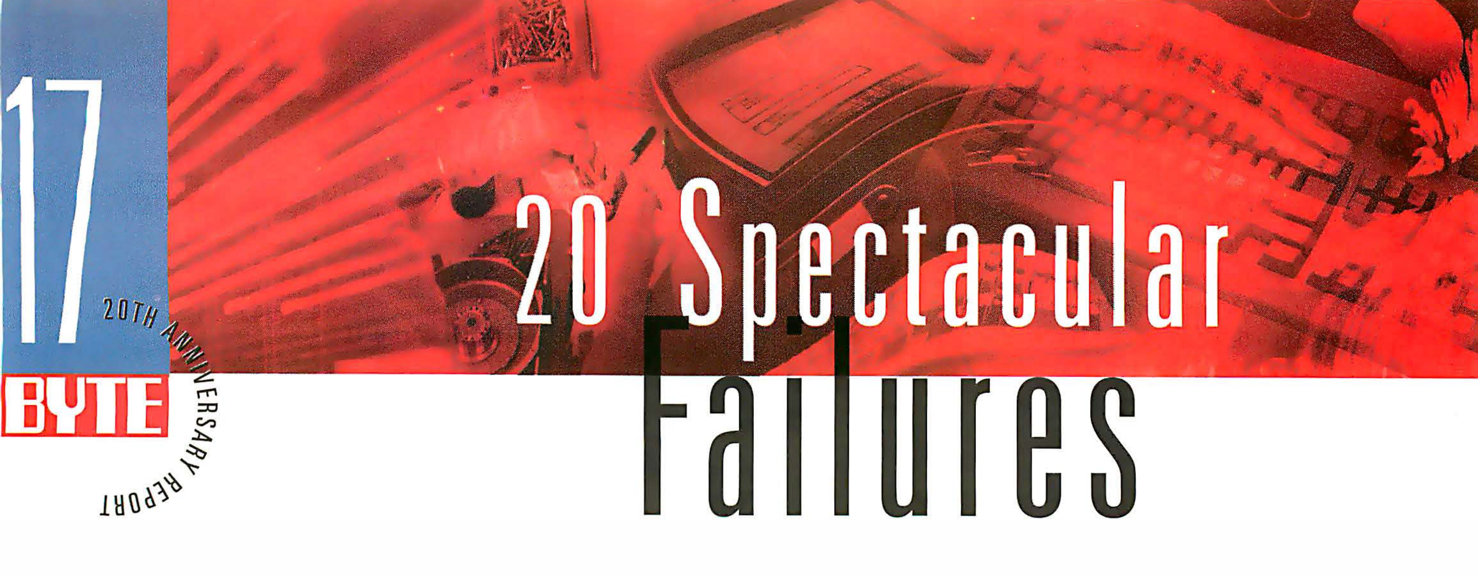






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20 Spectacular Failures

Sometimes you get it; sometimes you don't. Why should computer companies be any different? There doesn't seem to be a single one that has the complete Midas touch.

■ Apple III

Apple Computer

Apple's first designed-for-business computer was plagued with hardware gremlins after its 1980 debut. Or perhaps gremlins isn't the right word—ogres might be more accurate. At one point, Apple advised users of malfunctioning units to lift their machine several inches off the desktop and then drop it—to reseat loose chips. The Apple III engineering group was disbanded in 1984.

■ VisiOn

VisiCorp

This integrated software package had a slick windowing interface and was supposed to be the smash-hit sequel to VisiCalc, the first spreadsheet program. But two years after it appeared in 1982, VisiOn was "visioff."

■ MSX

Microsoft

You think everything Microsoft touches turns to gold? Think again. MSX, a Z80-based computer standard developed with several Japanese companies in 1983, flopped so badly that only a handful of MSX machines were ever sold in the U.S. Somehow Microsoft survived.

■ Lisa

Apple Computer

With 1 MB of RAM, 2 MB of ROM, a 5-MB hard drive, and the first GUI ever seen on a personal computer, the Lisa was a breakthrough machine in 1983. It cost $10,000 and crawled like a slug, however. When the Macintosh arrived in 1984 at $2495, the Lisa was doomed. In 1989, the last 2700 Lisas were buried in a Utah landfill.

■ Aquarius

Mattel

When Mattel demonstrated this computer at a trade show in 1983, employees had to conceal one of the keys with masking tape. For some bizarre reason known only to Mattel engineers, the Aquarius had a convenient key that instantly rebooted the computer and wiped out all your data.

■ DEC Rainbow

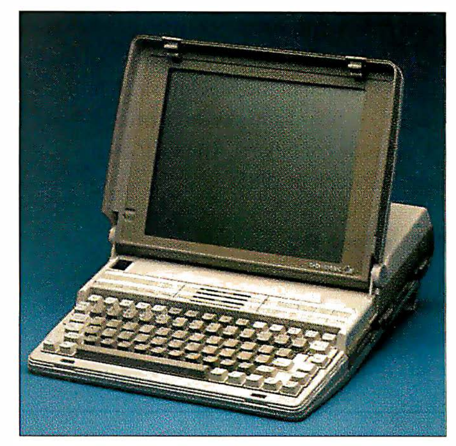
Digital Equipment Corp.

In the early 1980s, several companies tried to sell computers that ran MS-DOS but weren't IBM PC–compatible. One was the DEC Rainbow, which became famous as the computer that couldn't format its own floppy disks. You had to buy preformatted blank disks from DEC—at a considerable markup. The Rainbow quickly faded in 1985.

■ Gavilan Mobile Computer

Gavilan Computer Corp.

This early 8088-based laptop had an eight-line LCD screen, an innovative touchpad, and an optional printer that attached to the back. But it wasn't PC-compatible and suffered from technical problems. In 1984, a Gavilan executive announced, "The microcomputer industry is entering a new chapter—Chapter 11."



DIM PROSPECTS FOR DATA GENERAL.



APPLE'S LISA: BEAT OUT BY A GUY NAMED MAC.

■ Adam

Coleco

For the incredibly low price of $599, eager buyers got a Z80-based home computer with a daisy-wheel printer, a 512-KB tape drive, and bundled software—luxurious features in 1984. But the Adam was so poorly designed that it sometimes erased its own tapes during boot-up. It was nicknamed the "Adam bomb."

■ PCjr

IBM

This cruelly crippled cousin of the IBM PC was supposed to conquer the home market in 1984. Instead, it was overshadowed by Apple's launch of the Macintosh, and its chiclet keyboard and sky-high price drove away hordes of buyers. The PCjr died a laughingstock in 1985.

■ Mindset PC

Mindset

Too far ahead of its time, the Mindset tried to bring dazzling color graphics to business users in 1984. Unfortunately, it wasn't completely PC-compatible, and most business users thought color graphics were for game machines. (Little did they know....) However, the Mindset became the first computer in the New York Museum of Modern Art's permanent industrial collection.



GAVILAN HAD THE RIGHT IDEA BUT WASN'T PC.

■ DG/One

Data General

This 10-pound laptop had a 12-inch LCD screen, a mighty impressive feature in 1984. In theory, anyway: The nonbacklit screen was almost readable if the light was just right and you had the vision of Superman. Most people didn't.

■ Osborne II

Osborne Computer

In 1984, Adam Osborne announced that he would introduce a new version of his Osborne I, the first successful portable computer. In anticipation of the Osborne II's superior features and performance, sales of the Osborne I plummeted. When the Osborne II was delayed, the company's finances plummeted. Within months, Osborne was in bankruptcy court.

■ Jazz

Lotus Development

This 1985 integrated software package was supposed to turn the Mac into a whiz-bang business machine. But most reviewers said that Jazz didn't boogie, and Microsoft Excel outsold it 3 to 1. After Microsoft introduced its own integrated software, Works, Jazz sang the blues.

■ **TopView**

IBM

Preceded by a year of hype and ballyhoo, TopView was supposed to bring multitasking to DOS programs on IBM PCs. In 1985, however, the typical PC had an 8088 or a 286 CPU with 256 to 640 KB of RAM. Hardware and compatibility problems soon droppedTopView out of sight.

■ **Windows 1.0**

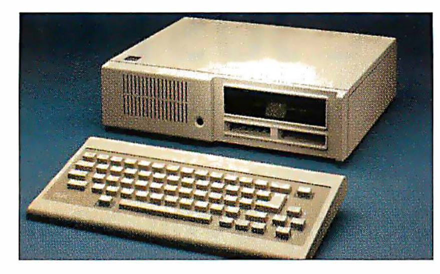
Microsoft

This is the only spectacular failure that eventually made a comeback and became a spectacular success. Announced in 1983 and shipped in 1985, Windows 1.0 was so crude that it was mocked by Mac users and largely ignored by PC users. Not until Microsoft released version 3.0 in 1990 did Windows become a hit.

■ **Access**

Microsoft

We're talking about the 1985 terminal program, not the 1992 relational database. Need we say more?



PCJR: CHICLETS ARE FOR GUM—NOT FOR KEYBOARDS.

■ **PC Convertible**

IBM

Reviewers weren't exactly thrilled with IBM's first laptop in 1986. IBM retailer president Jay Rosovsky responded, "So what? It's going to sell well because it says IBM and might legitimize a lap market that's been wallowing. I don't think it's technologically great shakes." He was wrong, and he was right.

■ **dBase IV**

Ashton-Tate

Released in 1988 after long delays, dBase IV was so riddled with bugs that many users fled back to dBase III Plus. Two years later, dBase IV 1.1 finally fixed some of the bugs, but the damage was done. Borland bought Ashton-Tate in 1991 and spent three more years porting dBase to Windows.

■ **Momenta Pentop**

Momenta

This 386-based portable pen computer could run either Windows or a proprietary GUI environment and was considered intriguing enough to make the cover of BYTE in November 1991. But it weighed 7 pounds, cost $4995, and was hobbled by poor handwriting recognition. After its shining Momenta in the sun, the company expired in 1992.

■ **OSI**

International Standards Organization

OSI (Open Systems Interconnection) is a seven-layer reference model for network protocols that was supposed to set a new standard for interoperability. Thanks to strong backing from the federal government, it never had a chance.

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Noted & Notorious Hacker Feats

Hackerdom is divided into two parts: technologically adept and clever people, who could write a computer game in a night, and, sadly, irresponsible slimeballs, who hijack computer and phone systems for the heck of it. Here is a look at some of the amazing stunts that have been pulled by both hackers and crackers.

■ Breaking, Stealing, and Phone-Phreaking

When Kevin D. Mitnick was finally bagged by the FBI on February 15, 1995, in Raleigh, North Carolina, he had been on the lam since 1992 from a three-year probation—part of his sentence from a 1989 conviction for stealing software from DEC. This accomplishment made him the first person convicted under a law against gaining access to an interstate computer network for criminal purposes. Mitnick also did a year in the slammer for that one. Physicist and computer security expert Tsutomu Shimomura assisted authorities in tracking Mitnick down this time, after Mitnick invaded Shimomura's own computer during an assault on San Diego Supercomputer Center systems. If the latest allegations stick, Mitnick faces a somewhat more stable future of up to 35 years in prison and $500,000 in fines.

Besides stealing DEC's VMS OS—valued by DEC at a million dollars—and necessitating some 18 months and $160,000 on DEC's part to defend its compromised computers and track him down, other alleged feats on Mitnick's résumé include breaking into a California motor vehicles database, lifting 20,000 credit card account numbers from an on-line service, gaining control of New York and California telephone switching hubs via modem, eavesdropping on phone calls, mutating basic home telephones into quarter-demanding pay phones, and stashing data he filched from other networks in files of the California-based Well on-line service.

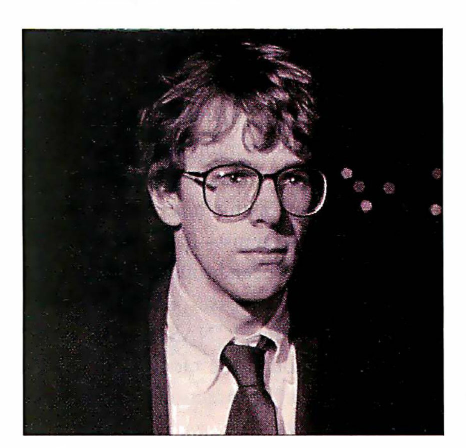
In addition to typing skills, Mitnick apparently has a knack for keeping a step ahead of pursuers by perusing their plans on their own E-mail systems, scanning police bands for mentions of his whereabouts, and using cellular phones. Mitnick has an interesting system for getting systems administrators to bestow upon him network access codes, passwords, and privileged status for accounts he controls—the keys to their computer kingdoms: He asks them to, disguising his true identity and offering some plausible tale. During his stays in jail, he is routinely forbidden to dial telephone numbers himself lest he wreak some phone-phreaking black magic havoc. He has denied ever cracking the NORAD (North American Air Defense) Command computer, a rumored exploit that supposedly inspired the movie *War Games*.

■ The Worm That Roared

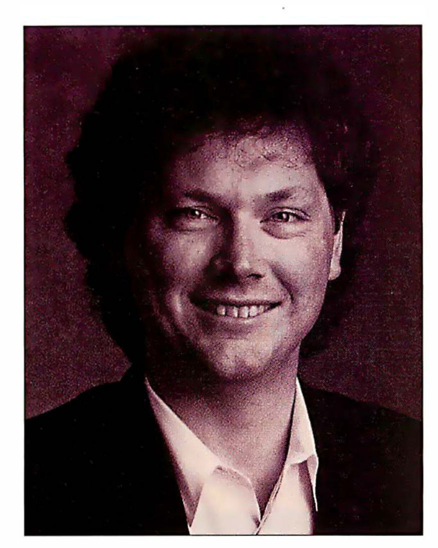
At 8 p.m. on November 2, 1988, 22-year-old Cornell University graduate student



KEVIN MITNICK: A PHREAKER SO DANGEROUS SOMEONE ELSE MUST PLACE HIS ONE PHONE CALL.



HERE HE IS, A MAN WHO WORMED HIS WAY INTO OUR HEARTS: ROBERT MORRIS.



YES, THERE IS JOY IN MUDVILLE—BILL JOY, THAT IS, INVENTOR OF A HOST OF UNIX UTILITIES.

Robert Tappan Morris launched a worm program that he had written from an MIT account. Imagine his surprise upon learning that his worm—designed specifically to traverse the Internet autonomously, finesse Unix loopholes he had laboriously researched, exploit the eccentricities of sendmail, scan lists of addresses for weak links, fool investigators into thinking it came from Berkeley, guess at passwords using a list of hundreds of common ones, and duplicate itself ceaselessly—was causing trouble on the network.

This computer cancer multiplied exponentially, filling up memories, stuffing disk drives, and consuming execution resources until machines began crashing one after another. Within hours, more than 6000 computer systems—fully one-tenth of the Internet—had been brought to their knees, affecting businesses, universities, the federal government, NASA, and the Air Force. Days of round-the-clock work were required to purge the infection from the systems and remedy the injury that had been done. Workers and researchers lost days of active computer time. A new government team of experts, CERT (Computer Emergency Response Team), was organized specifically to deal with any future incidents like the Morris worm.

Because he had discussed his worm-to-be with friends for weeks before launch day, it did not take authorities long to put two and two together and zero in on Morris. One of the first to be tried and convicted under the Computer Fraud and Abuse Act of 1986, Morris faced possible sentences of up to five years in prison and $250,000 in fines but received a slap on the wrist: only three years of probation, 400 hours of community service, and a $10,000 fine. It was pointed out by his defense that the worm did not actually delete or modify any files—small comfort to those who had to deal with the mess and whose cost estimates ranged from a modest $15 million to over $100 million. Morris said he meant no harm.

■ Like Father, Like Son

Robert Morris, Sr., Robert T. Morris's father and by odd coincidence a computer security expert with the National Security Agency, used to vie with rival Ken Thompson, one of the inventors of Unix, when both worked for Bell Labs. Legend has it that Morris, Sr., once typed two specific characters into a terminal and brought down one of the first versions of Multics. Déjà vu.

■ The 75-Cent Solution

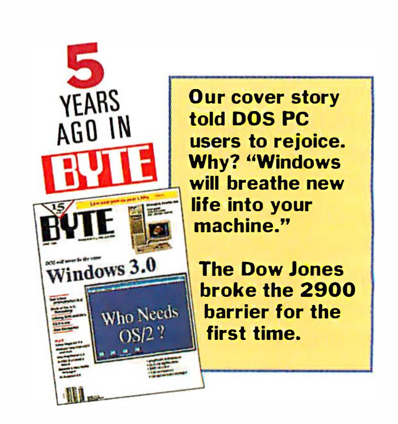
Clifford Stoll, by training an astronomer, by occupation a systems administrator at Lawrence Berkeley Laboratory, was investigating a 75-cent discrepancy in a supposedly defunct computer account that seemed to have been commandeered by an unauthorized user. The intruder was giving himself system privileges and creating accounts with names like Hunter, Jaeger, Benson, and Hedges. Although Stoll could have simply changed passwords, reassigned privileges, and so forth—effectively slamming the door on the intruder—he chose instead to monitor the intruder's on-line activity in the system. What the intruder was doing was using the LBL computers as a jumping-off point into the Arpanet, and then the Milnet (an unclassified military network), and thence to various Department of Defense computers on bases nationwide. From the files being examined, it was clear that the intruder was looking for secret American military information. Stoll was on the trail of a hacker spy.

The investigation took months, then years. By rigging connections that would page him whenever the intruder struck, Stoll was able to trace the connection back from LBL to a Tymnet node in McLean, Virginia, then to a bank of modems at Mitre Corp., and finally to West Germany. Stoll's girlfriend suggested using fake files as bait, a successful ruse that got the intruder to request defense information by mail, giving a name and address of one affiliate of the intruder. At that point, local police, the FBI, and the CIA became involved.

The intruder, it turned out, was one of a group of young German men hoping to get rich quick by peddling stolen software and information to the Soviet KGB. They began by selling stolen DEC software, then pilfered nonvital defense-related documents, and ended by selling each other down the river. Of the group, Karl Koch (aka Hagbard Celine, a fictional character that is, by contrast, a hero) committed suicide or was murdered—no one ever determined which; Hans Huebner (aka Pengo, a penguin in a computer game) had all charges dropped due to his tender years; Dirk-Otto Brzezinski (or Dob) received a 14-month sentence and a $2500 fine; Peter Carl received a two-year sentence and a $1500 fine; and Markus Hess (the actual intruder with a penchant for certain brands of cigarettes) received a 20-month sentence and a $5000 fine. None of the defendants served any time. Stoll testified at the trial and later wrote a book about his experience, *The Cuckoo's Egg* (Doubleday, 1989).

■ Uncrackable Code Creator

It's not often that one programmer gets to define an entire genre of software, but Philip Zimmerman has done it. His PGP (Pretty Good Privacy) is a freeware program that uses RSA (Rivest-Shamir-Adleman) -style public-key encryption algorithms to create secure encrypted versions of sensitive documents that can be sent over the Internet as E-mail without fear of compromise. The intended recipient then uses his or her code to decrypt the document. The security of the algorithm is



based on the computational difficulty of finding the prime factors (the "keys" to the code) of very large numbers.

Because the U.S. does not allow cryptographic hardware and software to be exported—even when, as here, the essence of the algorithm is mathematical theory that anyone can learn—Zimmerman has had a number of encounters with police types since PGP's debut in 1990. It seems strange that a democratic government would find itself among those opposing privacy, but computers make strange bedfellows.

■ Uncrackable Code Cracker

In 1977, Ronald Rivest, Adi Shamir, and Leonard Adleman (the RSA of RSA public-key encryption) created a short message with their code and challenged all comers to crack it. Arjen K. Lenstra, a scientist at Bellcore (Bell Communications Research), took up the gauntlet in 1993 and in May 1994 announced that RSA-129 (so-called because its public key is 129 digits—429 bits—long) had been cracked. RSA had to pony up $100, the reward offered for the feat.

The eight-month effort was no mere computer program. The complexity of finding the prime factors of large numbers required the organization of a "metacomputer": a loose confederation of many computers, each working on a piece of the problem. This particular project involved the spare execution cycles of some 1600 PCs and workstations and 600 teammates scattered along the Internet all over the country.

Not to worry about possible threats to security as a result of this particular code-cracking. First it's unlikely that such eight-month/1600-computer projects would go unnoticed. And second, actual real-life encryption uses keys 512 to 1024—or more—bits long. A 1024-bit RSA key would require 3×10^{11} MIPS-years to crack.

So, what did the decoded message say? "The magic words are squeamish ossifrage." Shoulda guessed.

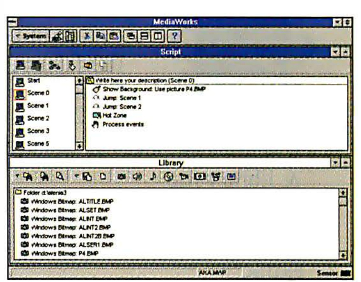
Hi, Liz, Guess Who?

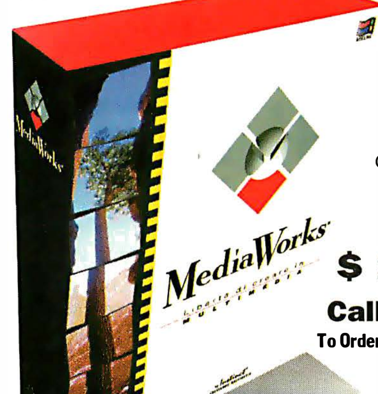
In 1994, an unknown temporary worker at British Telecom used his boss's passwords, conveniently taped to the side of his computer monitor, to ferret out the secret not-published-in-any-directory phone numbers of Her Royal Majesty the queen, Prime Minister John Major, and several top-secret MI5 installations, among others. Freelance Scottish journalist Steve Fleming saw a scoop and sold the tale to *The Independent*. In the meantime, the list of phone numbers was also posted on the Internet before it was yanked by investigating officials. Then, the unknown temp turned out to be—Steve Fleming. No one knows how many unexpected phone calls Her Majesty has had to field.



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■ The Joy of Ex

The many achievements of Sun Microsystems cofounder Bill Joy are legendary, and anyone would garner Joy a bust in the Unix wing of the Hacker Hall of Fame (to be constructed). In 1975, Joy became a Ph.D. student at UC Berkeley. Captivated by Unix, but unhappy with the `ed` line editor, he took the code for the `em` ("editor for mortals") editor (supplied by developer George Coulouris) and in a week produced most of the `ex` editor. In 1976, Joy wrote an improved Pascal compiler for Unix that became a standard Pascal programming tool. In 1978, he produced the first BSD (Berkeley Software Distribution) of utilities and began distributing BSD on tape. That same year, he created the `vi` editor and distributed the 2BSD (Second Berkeley Software Distribution). The 3BSD was a complete bootable system. In the early 1980s, Joy took the nascent TCP/IP and in a few weeks was running it satisfactorily between test machines. In one night, he wrote the utilities `rcp`, `rlogin`, and `rsh` for temporary use: They're still going. Joy also created the C shell for BSD, and it was subsequently adopted in AT&T's own Unix System V release 4.0. No one person has done for Unix what Joy has.

■ Legion of Doomed

The self-styled LOD (Legion of Doom) was basically a bunch of fun-loving guys (fun here having the special meaning *seizing control of telephone lines and switching equipment, eavesdropping on private phone conversations, unauthorized logging on to phone company computers, messing up telephone billing information, and helping others to do the same*). Naturally, the pursuit of such a unique variety of fun requires some pretty specialized know-how, such as BellSouth's internal technical specifications for the 911 emergency telephone network. In 1990, the boys from LOD's Georgia franchise managed to overcome their ingrained bourgeois notions of personal property, purloined a copy, and were caught. The value of the document in question ranged from $20 to $24,639 to $70,000, with value definitely being in the eye of the beholder. BellSouth also maintained that the LODsters had lifted log-ins, passwords, and connect addresses with a value of $233,800 and that it had spent $1.5 million in fingering them and a further $3 million defending the company



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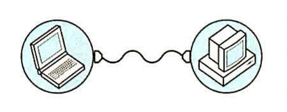
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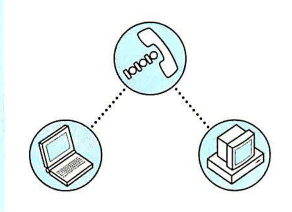
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from them. Convicted defendants Franklin E. Darden, Jr., Adam E. Grant, and Robert J. Riggs were given sentences of 14 months, 14 months, and 21 months, respectively, and ordered to pay restitution of $233,000 to BellSouth. Life isn't always fair.

■ Nerdz n the Hood

In contrast to the LOD (characterized by some as well-off white guys), the MOD (Masters of Deception, whose initials were deliberately chosen to be one up on LOD) was a posse of multiethnic teenagers mainly in working-class Brooklyn and Queens. Their definition of fun was eerily similar, however, perhaps a tribute to the social empowerment possible with computers. This gang was adept at invading the systems and networks of powerful entities, including AT&T, Bank of America, TRW, and the National Security Agency, displaying a mastery of telephone, network, Unix, and VAX arcana to rival the experts in the invadees mentioned but using only the most basic equipment (like a Commodore 64). Besides the usual telephone-torturing shenanigans, the MODers could also access and circulate supposedly private credit reports. The MODs and the LODs were constantly staging skirmishes against each other, mainly in the form of bizarre phone pranks that caused great collateral damage to the phone service of innocent bystanders.

In 1991, investigators from a number of agencies, including New York Telephone's investigative unit, the FBI, and the Secret Service, used the first wiretaps ever in a hacker case to unmask the MODs. Members included Messrs. Mark Abene (Phiber Optik), Julio Fernandez (Outlaw), Eli Ladopoulos (Acid Phreak), John Lee (Corrupt), and Paul Stira (Scorpion). In 1993, Abene received a one-year sentence, while Ladopoulos and Stira each received six-month sentences, plus probation and community service time. Because they were teenagers at the time of the acts for which they were convicted, and because their subsequent behavior has been good, observers expressed regret at the sentences.

■ MacPuzzle

Besides everything else he did to help get the first Macintosh out the door, Andy Hertzfeld wrote all the first desk accessories. Most of these were written in assembly. However, to show that desk accessories could also be written in higher-level languages, Hertzfeld wrote a demonstration puzzle game desk accessory in Pascal. Like its plastic counterparts, users moved squares around until the numbers 1 to 9 were in order. As time began to get short, the decision was made that the puzzle, at 7 KB, was too big (and too game-like) to ship with the first Macintosh. In a single weekend, Hertzfeld rewrote the program to take up only 800 bytes. The puzzle shipped with the Mac.

■ Software Immortality

Quick, look at the beginning of any EXE program that runs on DOS, Windows, NT, or OS/2. Although you may never have noticed it before, they all start with the two ASCII characters MZ. Why MZ? Those are

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Hacks, Cracks, Phreaks, and Feats

HACKERS ARE THE "GOOD GUYS," CREATING REMARKABLE SOFTWARE IN RECORD TIME. CRACKERS ARE HACKERS GONE BAD.

the initials of Microsoft programmer Mark Zbikowski, who has thereby achieved a kind of immortality (as long as people are running DOS-compatible programs).

■ Pirates, Ho!

Using the computer system at Florida State University as a stepping-stone to the Internet, software pirates in 1994 illegally uploaded IBM's OS/2, Microsoft Windows 95 beta, and other commercial programs to an area where anyone on the Internet could snag them for nothing. As a result, the Windows 95 beta is currently one of the most pirated and most posted programs on the Internet.

■ Gotta Finder

It sounds like a strange adventure game. You have six months until your company ships its revolutionary new computer and millions of people will turn it on and see—what? Well, that was the problem haunting Steve Capps and Bruce Horn in the summer of 1983. With the Mac's announcement scheduled for January 1984, they had to code what would come to be known as the Mac Finder—the file-manipulation and application interface that "knowledge workers" would be looking at and using day in and day out. Despite what you've heard about Apple simply lifting the Xerox Star's interface, every detail of the Mac's interface was discussed, experimented with, and agonized over for months. Some aspects were inherited from Apple's failing Lisa. Steve Jobs offered suggestions and vetoes. Designer Susan Kare took care of the aesthetics. The result was an interface people still point to as the way to do it right. And it ran in 50 KB.

■ A1 Effort

In 1978, Harvard Business School graduate student Dan Bricklin had an idea for a kind of electronic blackboard that would automatically do calculations. His "visible calculator" became VisiCalc a year later, developed with Bob Frankston and published by Personal Software. The first electronic spreadsheet, VisiCalc appeared first for the Apple II computer—its 32-KB total size fitting comfortably into the Apple II's maximum of 48 KB of memory. Every spreadsheet since has duplicated features that VisiCalc premiered: automatic recalculation, labeled rows and columns, built-in math and business functions, and the ability to change parameters to do what-if analysis. Its under-200-page manual is in marked contrast to the multivolume bricks for today's spreadsheets.

■ St. Paul, Oscar Wilde, and...

In 1979, while hoosegowed in Pennsylvania's Northampton State Prison for offenses of the phone-phreaking kind, John Draper (aka Cap'n Crunch, after a brand of cereal whose free toy whistle's pitch could switch phone lines so phreaking might begin) wrote the word processing program Easy Writer on a computer provided as part of his rehabilitation program.

■ Rebel Without a Clue

Bulgaria's otherwise-unknown Dark Avenger creates and unleashes a plethora of computer viruses all over the world. He has also produced a virus-making toolkit to make it easier for like-minded misanthropes to foul up the computers of total strangers. Romantic enough to name a virus after the American virus researcher Sara Gordon, who reputedly interviewed him, his main satisfaction seems to come from causing misery to millions of computer users the world over. What's he avenging? Who knows?

■ Hackers in Space

NASA astronaut Richard J. Hieb assisted in the dramatic rescue of the off-course $150 million Intelsat IV satellite in May 1992. Maneuvering the space shuttle (Endeavour, in this case) to rendezvous with another object in space is a surprisingly complex chore, rendered more difficult by traditional radar technology's inability to accurately measure the distance and relative speed of objects that get that close and move that slowly relative to each other. Luckily, on this rescue mission, they were employing a new laser-assisted system with software written by Hieb himself.

Hieb began writing his Payload Bay program (in C) in the early 1980s on his home computer. When he actually used it, he was quite far from home, running Payload Bay on one of NASA's Grid laptops. The OS? Plain old down-to-earth DOS.

■ Dial H for Hacker

When a Chicago-area real estate company started having trouble with its telephone voice-mail system in 1989, it had unwittingly exposed the tip of a nationwide criminal iceberg. Intruders were breaking into voice-mail systems, creating their own voice-mail accounts with which to barter stolen credit card numbers, changing passwords to lock out the legitimate users and administrators, and then using the systems to dial out again—toll free. They would use the stolen credit card numbers to buy Western Union money orders that their leader eventually turned into cash, kicking back a percentage to over 150 accomplices nationwide. They would also crack corporate PBX codes, enabling them to make





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unlimited, free long-distance calls. Hundreds of long-distance calls for hundreds of thousands of dollars were billed to the helpless voice-mail and PBX owners. The criminal ring stole over $9000 in charged merchandise, $1000 in money orders, $30,000 in voice-mail service, $250,000 in telephone service, and $1.2 million in PBX long-distance telephone service.

Who was the apparent mastermind of this scheme? Agents found over 150 telephone credit card numbers, over 250 bank credit card numbers, and dozens of PBX "extender" codes in the possession of a 35-year-old Chicago mother of two, Leslie Lynn Doucette (Kyrie). She was sentenced to a 27-month prison term in 1990.

■ The Wizard of Woz

Steve Wozniak began designing a computer partly because he didn't have enough money to buy one. The results were the Apple I and Apple II computers. Wozniak also wanted to build the kind of computer he wanted to use. At the time, many computers relied on cassette tapes to save and distribute programs and data. Wozniak designed a 5¼-inch disk drive system for the Apple II, reckoning—correctly—that disks would become a tad more popular than cassettes. Unlike other disk drive systems—IBM's comes to mind—that were based on a conglomeration of electronics and mechanical components, Wozniak's system was based completely on software control of the drive. As a result, Apple II drives had the flexibility to read and format a variety of disks—hard-sectored, soft-sectored, or whatever—without hard-wired preset settings. The software implementation also meant that expensive and complex interface boards were not necessary, making the Apple drives simpler and cheaper.

The Apple II had rudimentary sound but composite video and a simple and compact layout. Wozniak made sure the Apple II had expansion slots in the motherboard to allow simpler upgrading (like Microsoft's CP/M emulation board to run WordStar), a feature IBM later included in the first IBM PC. Wozniak also became a master of the MOS Technology 6502 chip, not because it was a more capable microprocessor than Motorola's 6800 or Intel's 8080, but because it was cheaper—an important consideration whenever starting a multibillion-dollar industry from a garage.

4 YEARS AGO IN BYTE

BYTE starts a new series of "language survivors." First up: FORTRAN.

Haitian President Jean-Bertrand Aristide and his democratic government are deposed in a military coup.



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Elite 2864I-S/T | LED, ISDN (S/T interface)
Elite 2864 | LED, 2 wire dial-up/leased line
Elite 2864L | LED, 2 wire dial-up, 2/4 wire leased line
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LS 9000	9.1 GB	LS 5.25"
**RS 9000	9.1 GB	RS 5.25"
LTX	Array Controller	LT 3.5"
**RTX	Array Controller	LT 3.5"/RS 5.25"

* Also available for rackmount configuration.
** Rackmount configuration only.











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Circle 341 on Inquiry Card (RESELLERS: 342).

19 20TH ANNIVERSARY REPORT BYTE

Famous Vaporware Products

■ Xanadu
Ted Nelson

Nelson first conceived his futuristic vision for hypertext way back in 1960; although his idea inspired countless products, Xanadu is still pending. Autodesk worked on it from 1988 to 1992; Nelson later hooked up with Japan's Sapporo HyperLab.

■ Ovation
Ovation Technologies

The term *vaporware* was first coined to describe this integrated software package for DOS. Announced in 1983, it never shipped. That was 12 years ago.

■ Windows 1.0
Microsoft

"Microsoft Does Windows!" gushed InfoWorld in 1983. Perhaps, but not for two more years.

■ Macintosh Office
Apple Computer

Steve Jobs's infamous "reality distortion field" was running in overdrive when he announced this networking solution in 1985. It didn't become real until 1987.

■ 1-2-3/G
Lotus Development

The first graphical version of Lotus 1-2-3 (for OS/2) was announced in April 1987 but wasn't delivered until September 1990.

■ Wingz for Windows
Informix

Neat new tote bags at every Comdex. But until 1990, they were empty.

■ 1-2-3 for Macintosh
Lotus Development

Mac users had been waiting more than four years when 1-2-3 finally shipped in 1991. Unfortunately for Lotus, most of them decided it wasn't worth the wait.

■ Windows NT
Microsoft

In 1991, it was known as OS/2 3.0 or OS/2 NT. Then IBM and Microsoft had a little spat. When NT arrived in 1993, it was Windows all the way.

■ dBase for Windows
Borland International

Impatient dBase users tapped their toes for nearly five years. Many had walked away by the time the Windows version finally shipped in 1994.

■ Windows 95
Microsoft

Need we say more?

List #20 Top Garage Start-ups

Some people store cars in garages, and some also store garden implements and the detritus of the past. Others start multimillion-dollar companies in them. Beats cleaning up oil stains.


THE HP GARAGE IN PALO ALTO.

- **MOM, MAY I BORROW THE VAN?** Apple Computer
- **PASCAL, CHEAP** Borland International
- **PHILIPPE HAS A BIG GARAGE** Starfish Software
- **WIRES AND PLIERS** Cabletron
- **MOO-VING ON UP** Gateway 2000
- **NO EGO OR SUPEREGO INVOLVED** id Software
- **GET RICH QUICKEN** Intuit
- **IS THERE A DOCTOR IN THE HOUSE?** McAfee
- **WORTH 1000 WORDS** PictureTel
- **ON A KITCHEN TABLE, ACTUALLY** Sierra On-Line
- **US, TOO** BYTE
- **IT'S A LANDMARK** Hewlett-Packard

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4

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Reads and writes standard QIC tape formats.	✔		✔

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9 Three year warranty - We feel so confident about our products that we offer this spectacular warranty.

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60G1622/92G7204 (16Meg)	Value Point Performance, PC Server 4/66	609.00
92G7205 (32Meg)	Value Point Performance, PC Server 4/66	1239.00
6450902 (2Meg)	56, 57, 57SX,90, 95, P-75, 57SLC, Value Point 77 486DX2, 486SX, SVR 85	90.00
6450128/92G7200 (4Meg)	57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Mod-2123, 2133, 2155, Val Pt 77, 486CS2, 486SX, SVR85, Value Point 77 486DX2, 486SX, SVR 85	169.00
6450129/92G7428 (8Meg)	35SX, 40SX	339.00
6450130/92G7202 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC, Value Point 77 486DX2, 486SX, SVR 85	339.00
6451158/92G7208 (4Meg ecc)	486; 95XP; 95A (install in pairs)	199.00
6451159 (8Meg ecc)	486; 95XP; 95A (install in pairs)	399.00
92G7209/32G3720 (16Meg ecc)	9595 OPT	749.00

IBM NOTEBOOK & LAPTOP MEMORY

07G1415/07G1420 (4Meg)	Thinkpad 750, C, 700, C, 720, C, CL57SX	189.00
07G1416/07G1421 (8Meg)	Thinkpad 750, C, 700, C, 720, C, CL57SX	359.00
66G0095 (16Meg)	Thinkpad 750, C	629.00
66G0094 (4Meg)	Thinkpad 755, 360, 355, 340, 450	179.00
66G0094 (8Meg)	Thinkpad 755, 360, 355, 340, 450	339.00
66G0094 (16Meg)	Thinkpad 755, 360, 355, 340, 450	599.00
8189098 (4Meg)	Thinkpad 500, 510CS (3.3 volt)	189.00
8189099 (8Meg)	Thinkpad 500, 510CS (3.3 volt)	369.00
8189113 (16Meg)	Thinkpad 500, 510CS (3.3 volt)	619.00
79F0999 (2Meg)	LX40, N33SX, PS Note	103.00
79F1000 (4Meg)	LX40, N33SX, PS Note, Tkpd 350, 350c, PS Note 425	189.00
79F1001 (8Meg)	LX40, N33SX, PS Note	349.00
Hard Drive (524Meg, 710 Meg))	Thinkpad 750, 755, 360, 355	949.00/1149.00
(4Meg/16Meg)	Thinkpad 755 Dimm Modules	209.00/699.00
(4Meg/16 Meg w/Adap	Thinkpad 755	289.00/749.00
60G0378 (8Meg)	Thinkpad 350, 350c, PS Note 425	339.00
60G0379 (16Meg)	Thinkpad 350, 350c, PS Note 425	569.00
92F8804 (2Meg)	N45SL	109.00
92G7259 (4Meg)	Thinkpad 701C, CS, Butterfly	189.00
92G7261 (8Meg)	Thinkpad 701C, CS, Butterfly	369.00
92G7263 (16Meg)	Thinkpad 701C, CS, Butterfly	649.00

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MODEL	AMT. UPGRADED	CMPQ PART #	PRICE
DeskPro 386/33, 386/33L, 486/25, 486/33L, 486/50L, System Pro	2Meg Module	115144-001	99.00
	8Meg Module	116561-001	349.00
	32Meg Module	116568-001	1399.00
DeskPro 386/33L, 486/33L	(Exp Bd)	116569-001	279.00
DeskPro 386/25, 386/20	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	199.00
DeskPro 386S-16MHz	1Meg Exp Bd	113633-001	149.00
	4Meg Exp Bd	113634-001	279.00
	1Meg Module	113646-001	79.00
	4Meg Module	112534-001	199.00
DeskPro 386/20E	1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	279.00
	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	199.00
DeskPro 286N, 386N, 386SX20, all "M" series, sytem LT series, all "I" series	1Meg Module	118688-001	59.00
	2Meg Module	118689-001	89.00
	4Meg Module	118690-001	169.00
	8Meg Module	128877-001	355.00
M Series Exp Bd	0-64Meg	129160-001	189.00
DeskPro 386/16	1Meg Kit	108071-001	99.00
	4Meg Kit	108072-001	299.00
	1-2Meg Exp Bd	108069-001	239.00
	4-8Meg Exp Bd	108070-001	437.00
DeskPro 286 (ALL OF THESE MACHINES USE THESE MODULES: DeskPro 286, DeskPro 5/60, 5/66M, 5/66M, Prosignia 5/60, Proliant 100 5/60, Proliant 2000 4/30, 5/66, Proliant 4000 4/50, 5/66)	512K Kit	113012-001	49.00
DeskPro 5/60, 5/66M, 5/66M	8Meg Kit	149911-001	376.00
Prosignia 5/60	16Meg Kit	149949-001	676.00
Proliant 100 5/60	32Meg Kit	149912-001	1420.00
Proliant 2000 4/30, 5/66	64Meg Kit	149913-001	2476.00
Proliant 4000 4/50, 5/66	128Meg Kit	149914-001	5076.00
Prolinea 386 3/25S, 3/252S	2Meg	141738-001	90.00
	8Meg	141742-001	298.00
Prolinea 4864/25S, 4/33, 4/50, 4/66, CDS Enhanced Prolinea, Prosario series	2Meg	141683-001	95.00
	4Meg	141684-001	169.00
	8Meg	141685-001	339.00
Prosignia PC Server, 486/33, 486 DX2/66	8Meg	141685-001	339.00
	16Meg	149320-001	599.00
	32Meg	149147-001	1199.00

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LTE/286	4MegBd	117081-003	179.00
LTE/386S/20	4MegModule	121125-002	219.00
LTE LITE/20, 25, 25C	4MegModule	129769-002	219.00
LTE LITE/20, 25, 25C	8Meg Module	129769-003	439.00
LTE LITE/20, 25, 25C	16MegModule	129769-004	669.00
LTE LITE 425C/33C/25E/25L	4MegModule	142337-002	189.00
LTE LITE 425C/33C/25E/25L	8MegModule	142337-003	359.00
LTE LITE 425C/33C/25E/25L	16MegModule	142337-004	619.00
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SLT/386	4Meg Module	118305-001	219.00
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	8Meg	144790-002	353.00
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Contura 400, 410	4Meg/8Meg/16Meg		189/369/619
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	8Meg	146521-001	349.00
	16Meg	146531-001	619.00
Aero 4/25, 4/33	4Meg	190532-001	184.00
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T2000SXE/2200SX/T1800, 1850, C	8Meg	PC-PA2002U	359.00
T2100, 2105, 2150	4Meg/8Meg		189/379
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T4400SX, SXC T6400, T6600	4Meg	PC-PA2004U	189.00
T4400SX, SXC T6400, T6600	8Meg	PC-PA2005U	359.00
T4400SX, SXC T6400, T6600	16Meg	PC-PA2010U	689.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	189.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	349.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	16Meg	PC-PA2014U	652.00
T4700, 4800, 4850 (Hard Drive)	524Meg/710Meg		799/1098
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T3200SX	4Meg	PC12-PA8909	199.00
T5200/T8500	2Meg	PC10-PA8304U	114.00
T5200/T8500	8Meg	PC10-PA8313U	419.00
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ACER 763, 765, 782, 784, 786, 787,	4Meg/8Meg/16Meg		199/379/719
ACER 750	4Meg/8Meg/16Meg		189/379/629
ALR Venture	4Meg	12407980	249.00
Altima Virage	4 Meg/ 16 Meg		199/679
Altima Virage II	4Meg/8Meg/16Meg		199/369/622
AST Ascentia 900N, 800N	4Meg/8Meg/16Meg		189/379/629
AST Bravo & Explorer	4Meg/16Meg	501255-001, -002	189/679
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500814-003	189.00
AST Power Exec 3/25C, 425EL, 425SL	4Meg/16Meg	501166-001, -003	199/629
AST Power Exec 4/33SL	4Meg/16Meg	501318-001,002	194/769
AT&T Globalyst 200	4Meg/8Meg/16Meg		199/389/679
AT&T Safari NSX/20	4Meg	PEC 37651	259.00
Austin DX4, DX2, SX2, SX Series	4Meg/16Meg		199/699
Bondwell B310, Plus	1Meg	23050-09100	69.00
Bondwell B310V, SX	1Meg		109.00
Bondwell B310V, SX	4Meg		229.00
Canon Innova Book 150	4Meg/16Meg		199/769
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Canon Innova 486	2Meg/4Meg/8Meg		109/209/449
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Canon Notejet 486	4Meg/ 8 Meg		199/389
Chaplet 486	4Meg/16Meg		199/679
Chicony NB5	4Meg/16Meg		199/679
Compuadd 425TX Notebook	4Meg/16Meg		199/699
DEC HiNote	4Meg/8Meg/16Meg		199/379/669
Dell Lattitude M, MC, MCX	4Meg/8Meg/16Meg		189/379/639
Dell Lattitude XP, 475, 4100, 4100CX	4Meg/16Meg		199/639
Dell Latitude 486, 425, 433C, 433CX, 450, 450CX	4 Meg/16 Meg		199/679
DTK 4T100P Notebook	4Meg/8Meg/16Meg		189/369/639
Epson ActionNote 650, 650c	4Meg/8Meg/16Meg		209/399/659
Epson ActionNote 700, 700c, 700cx	4Meg/16Meg		199/639
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Epson ActionNote 4000 Notebook	6Meg		279
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HP Omnibook 530, 600	4Meg/8Meg/12Meg		189/379/549
HP Omnibook 4000	4Meg/8Meg/16Meg		199/379/649
Leading Edge Aviva	4Meg/16Meg		199/639
Lexmark SE10	4Meg/8Meg		209/399
Magnavox Metalis	1Meg/4Meg	286, 386SX	109/199
Midwest Micro Elite SX-25, SX33, DX2-50, DX2-66	4Meg/8Meg/16Meg		199/389/629
Midwest Micro Elite Sndbk SX33, DX3-50, DX4-75, DX4-100	4Meg/8Meg/16Meg		199/389/629
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NEC Prospeed 386	2Meg	PC31-21	119.00
NEC Prospeed 386	8Meg	PC31-22	399.00
NEC Prospeed 286, 386SX-16, 386SX-20	4Meg	PC21-22, PC43-22	199.00
NEC Ultralite Versa, E, V	4 Meg/8Meg/16Meg/20Meg	OP4104	183/359/619/799
NEC Versa Removable Hard Drive	540Meg/710Meg/810Meg		859/949/1033
NEC Versa S	4Meg/8Meg/16Meg		209/379/799
Packard Bell 386SX, 286	1Meg, 4Meg	286, 386SX	109/179
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14,400/14,400 Data/Fax Modem	119	Multimedia Combo, Sound/SCSI	499
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Lan Ethernet Combo	Call	Type III 130 Mg Hard Drive	399
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Epson 6000, Action Laser	-	-	-	139	-	-	229	-	-	-	-	-
Epson Action Laser 1100, 1600	-	-	69	99	-	-	189	-	-	379	599	-
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HP Design Jet 600, 650, 200	-	-	-	89	-	-	175	-	-	349	-	-
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IBM Laser 4029, 4037	-	-	-	-	-	-	169	-	-	-	-	-
IBM Laser 4039, 4079	-	-	-	99	-	-	169	-	-	350	-	-
Konica LP-3110	-	-	119	189	239	-	-	-	-	-	-	-
NEC 90, 290	-	-	-	139	-	-	-	-	-	-	-	-
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Oki 400	-	-	-	104	-	-	-	-	-	-	-	-
Oki 400E, 400EX, 410E, 410EX	-	-	135	189	-	-	-	-	-	-	-	-
Oki 830, 840	-	-	-	109	-	-	-	-	-	-	-	-
Packard Bell PB 9500	-	-	-	139	-	-	227	-	-	-	-	-
Packard Bell 9815	-	-	-	159	-	-	269	-	-	-	-	-
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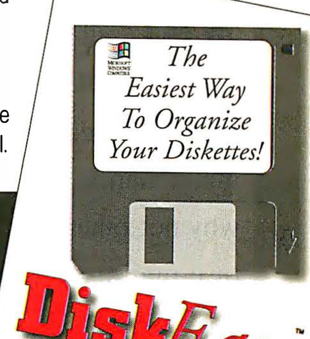
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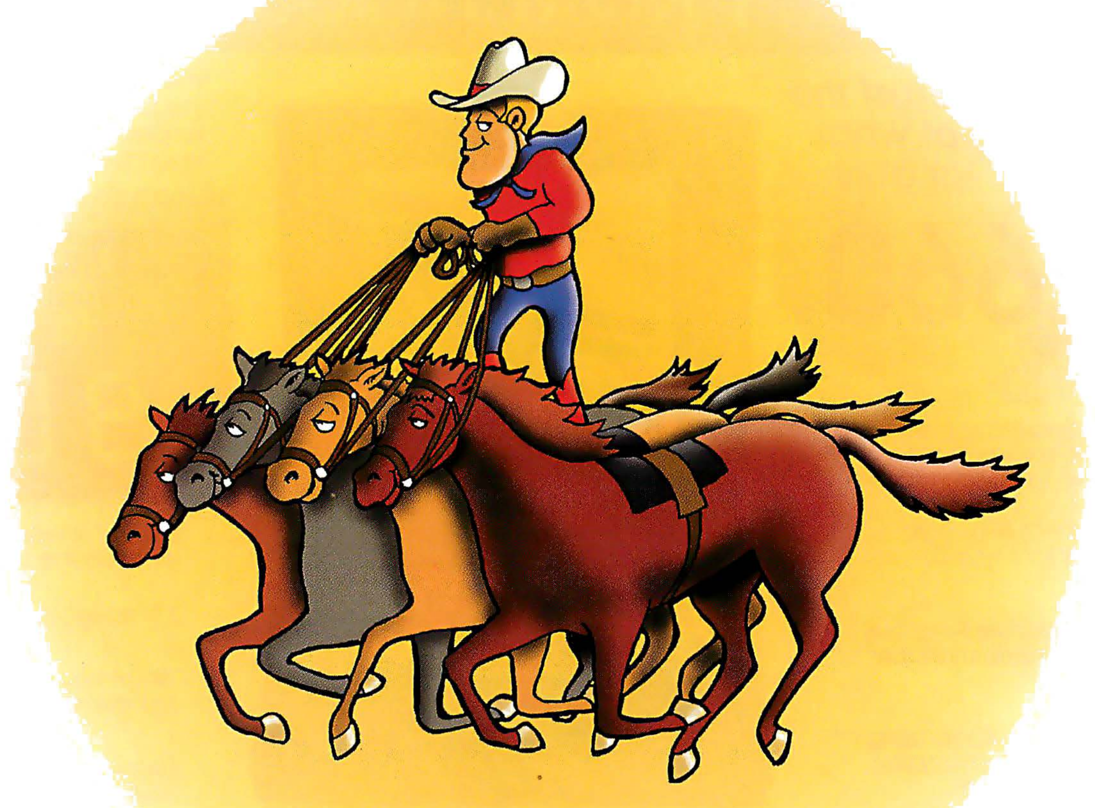
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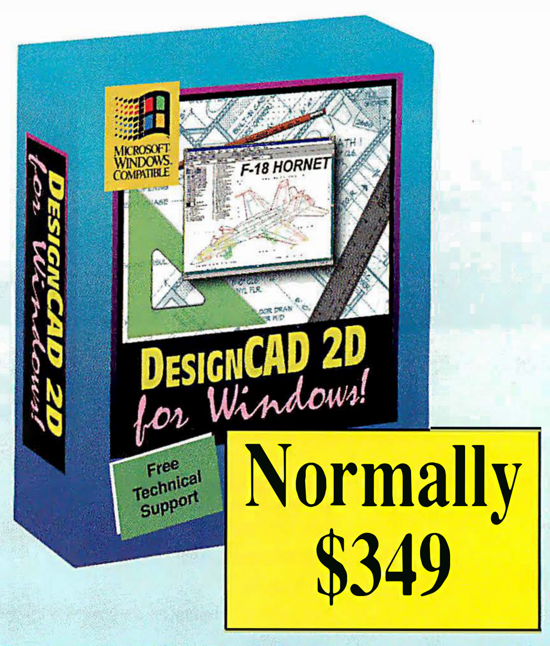


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Tilt/Rotation Control	NO	YES	YES
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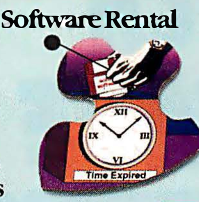
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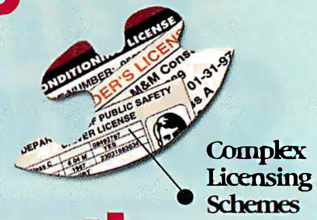




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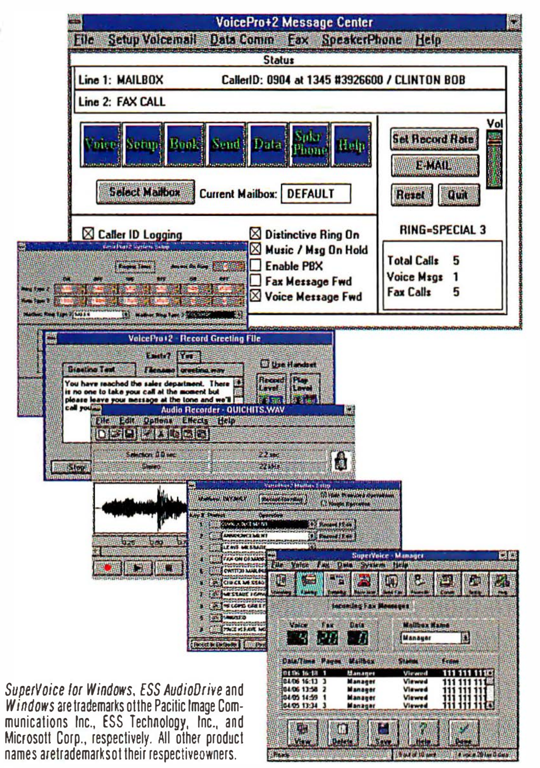
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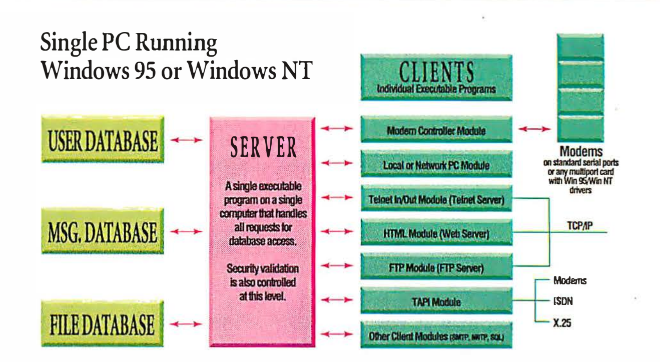
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ATSCA	*9P (F) to 25P (M) Adapter*	$2.49	$2.04
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AS-RAM-1M	*1 Mb Ram Buffer*	129
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***ETHERNET ADAPTER CARDs** are NE-2000/NETBIOS compatible, CSMA,IEEE802.3 protocol, distributed bus, 10Mbps, supports PC-LAN, MS-NET, NOVELL, built-in high performance transceiver drivers for ODI, NDIS, SCO UNIX, TCP/IP and has 8 IRQs for flexibility and on-board ROM socket.*

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110 Type RJ45 Jack INSERTS Available Colors: Ivory, Black, Red, Green, Yellow, Orange & Blue				
KJ-110WH	White	$5.50	$5.00	$4.58
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KP-IN	Blank Insert	$0.30	$0.25	$0.20
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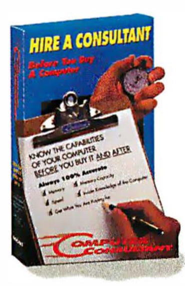
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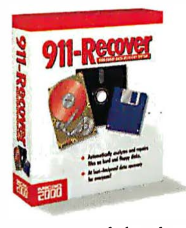
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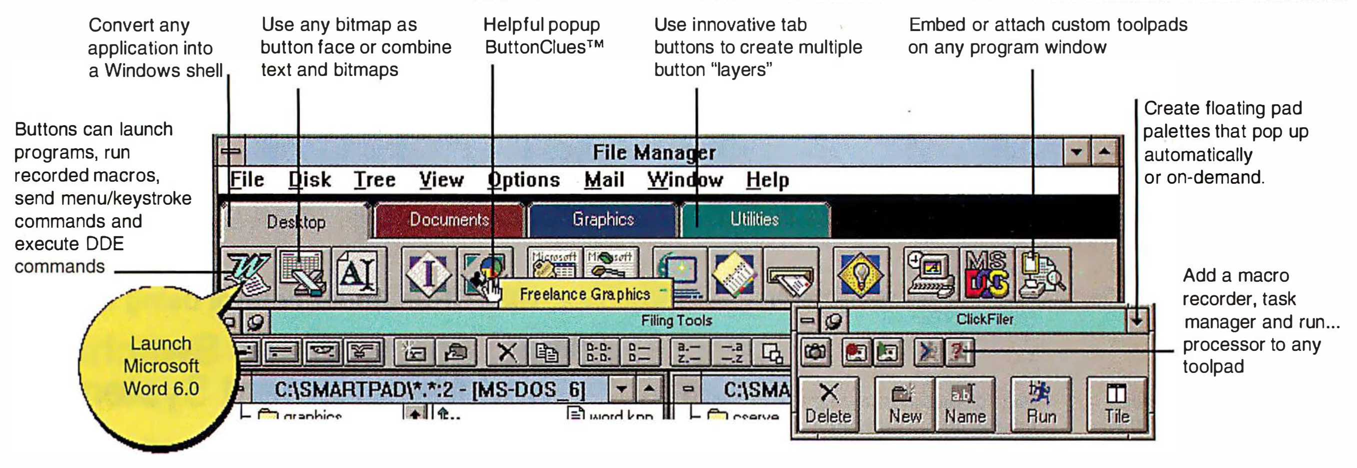
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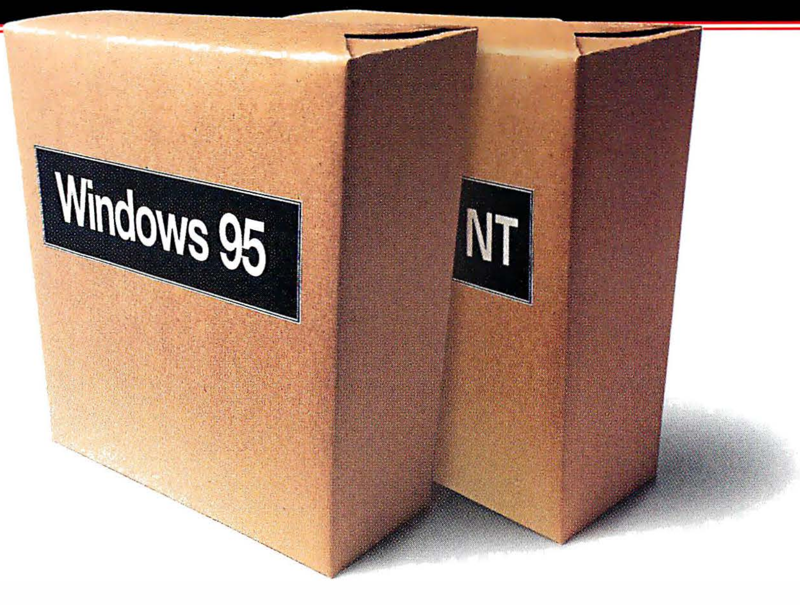
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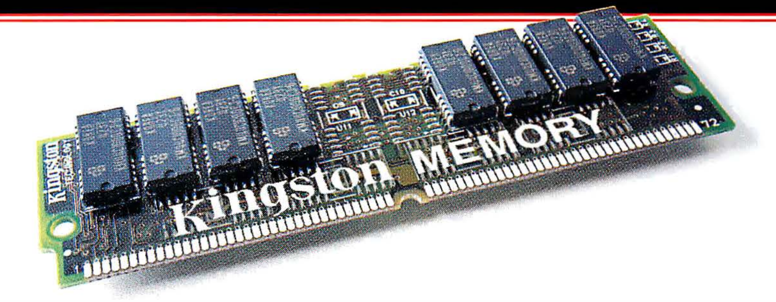
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Circle 225 on Inquiry Card (RESELLERS: 226).

Collision!

Despite cultural differences and compatibility problems, integration of computers and telephony is fast becoming reality



The wait is over. After years of broken promises and incompatible "standards," CTI (computer telephony integration) is ready. Hundreds of vendors have introduced products—from headsets, to vertical-market telephony applications, to development and design tools, to turnkey phone systems—that will enable your telephones, computers, and networks to work together.

Tying together today's two most important connectivity technologies isn't a new idea. CTI's promise has been discussed for years. But radically different technologies, competing interests, and incompatible standards have, until recently, put the connection process on hold. Now all that is changing.

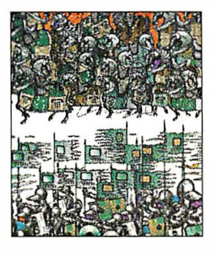
Look at the histories and business practices of the telephone and computer industries, and you might wonder how they could *ever* find common ground. For a variety of technical, economic, and legal reasons, the two industries have walked vastly different paths. But the potential has become too great to ignore. Savvy computer users now realize that harnessing the link between phone and computer can increase users' efficiency and improve customer relations—two code terms for making money.

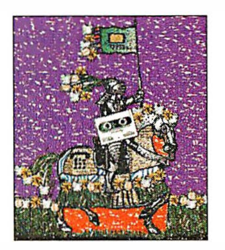
In "Standard Issue," James Burton discusses the basic technical issues of CTI. Architectural and standards issues are far from settled, and the company that wants to use CTI has to make important decisions concerning a bewildering variety of APIs, standards, protocols, and hardware configurations. Burton sorts through this mass of conflicting information and three-letter acronyms, identifying the major issues and players.

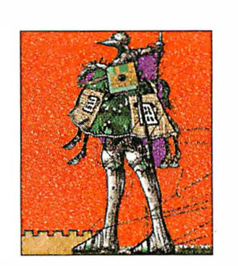
In "Building Telephony Applications," Burton looks at the types of applications that CTI makes possible. Since CTI is still in its early stages, it's probable that you'll have to develop your own custom CTI application. Burton discusses what you should look for in evaluating and choosing a development toolkit.

Finally, in "Telephony's Killer App," John P. Mello Jr. looks at several of the most interesting new telephony applications to be found. ■

—Russell Kay, Technical Editor







ILLUSTRATIONS: VICTOR GAD © 1995

STANDARD ISSUE

Integrating your computers and phones? Here's a guide through the maze of design approaches, technologies, standards, APIs, and industry politics.

JAMES BURTON



VICTOR GAD © 1995

Things used to be so simple. There was only one type of light bulb. Gasoline was all leaded. Mustard was only yellow. Now incandescent lights are being replaced with fluorescents and halogens, gasoline has at least three octane ratings, and mustard fills three shelves at the supermarket.

It's the same with telephones and computers. When they didn't need to talk to each other much, a modem was more than sufficient. But now, the business advantages of computer-based call control are forcing this unnatural bond. Springing up to cement the union are myriad APIs and hardware designs. Without an understanding of how they work and which are most likely to succeed, you could wind up with a CTI (computer telephony integration) system destined for the scrap heap.

CTI Architectures

Today's CTI systems generally fall into one of four different architectures or configurations, based on their approach to making the actual connections and managing calls. (See the figure "Four CTI Architectures" on page 202.)

Phone-centric systems are the easiest to implement; they only require a direct link from the phone to an external adapter that connects to the PC's serial or parallel port. They don't require extensive changes to an existing phone system. Users can have direct control over call routing (known as *first-party call control*). To transfer a call, for example, the user just clicks on an icon, and the PC sends a message to the switch that emulates a command from the phone requesting the switch to transfer the call.

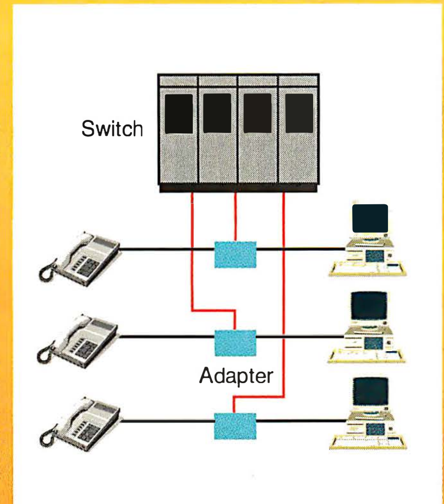
Many PBX vendors offer adapters that give that kind of control to the PC. Unfortunately, these adapters don't provide a connection to the phone line and can't be used to connect data or fax lines to the PC.

Server-centric systems connect your telephone switch to a server on your LAN. Here, the phone system becomes another

FOUR CTI ARCHITECTURES

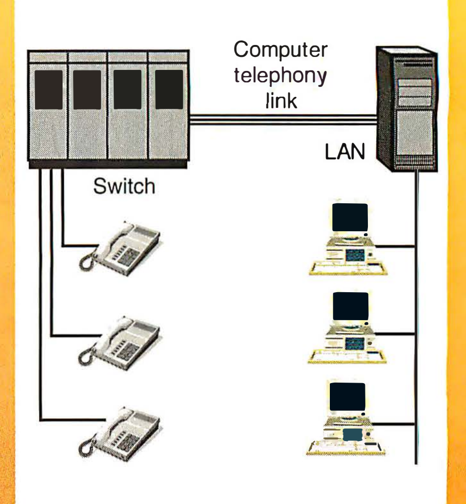
Phone-Centric

The phone is linked via an external adapter that connects to the PC's serial or parallel port (and soon via a USB [universal serial bus]). The PC is not directly connection to the phone line, but rather to the adapter.
ADVANTAGES: Such systems are easy to implement and don't necessitate extensive changes to an existing telephone system.
DISADVANTAGES: Today's adapters don't provide a connection to the phone line and cannot be used to connect data or fax lines to the PC. This will change with USB.



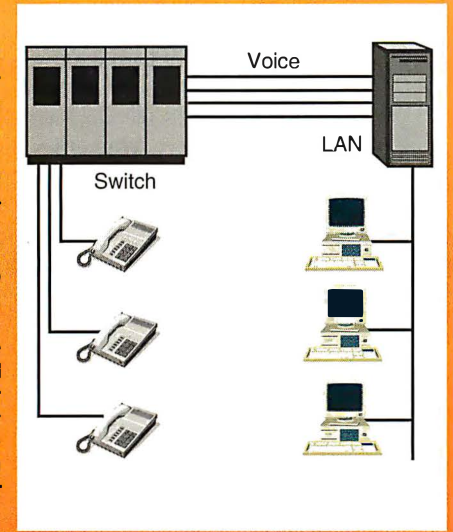
Server-Centric

Here the phone lines connect to a switch, which in turn connects to a telephony server on the LAN. The LAN server manages call routing, although it has to have the switch perform the actual transfers.
ADVANTAGES: No physical connection is needed between the phone and the desktop PC. Third-party call control is good for workgroups and call centers.
DISADVANTAGE: The server can't perform automated, intelligent switching of different types of calls—fax, voice, and data.



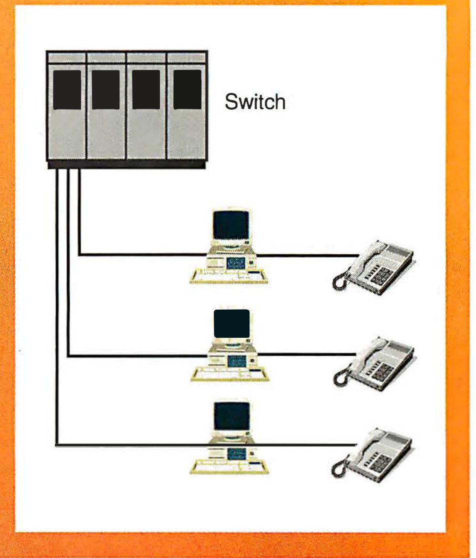
Voice-Server

Phone lines are connected to a board in a voice server that sits on the LAN. The server gets the voice or data call, but not control information—just the opposite of what happens in the server-centric configuration.
ADVANTAGES: This configuration provides access to the media stream (e.g., voice, data, and fax).
DISADVANTAGES: A phone line can only control a call that it has received or placed; it can't send other types of instructions to the switch. This architecture can be too slow for call-center operations.



PC-Centric

The telephone line and the phone itself are connected directly to an add-in board in the PC. The telephony board emulates the phone to the switch.
ADVANTAGES: This configuration provides a direct voice path from the phone into the PC, which is useful for I/O operations. Ultimately, it can eliminate the PBX entirely.
DISADVANTAGES: This is an expensive solution, because considerable processing power is required in each PC. If the system uses proprietary phones, it's even more costly.



part of the computer network, and you don't need a physical connection between the phone and individual desktop PCs. The LAN server, not the switch or the user, is responsible for routing calls (thus, it's termed *third-party call control*).

To transfer a call, the user clicks on the transfer icon, which sends a message to the server requesting that it transfer the call. The third party (the server) sends a message telling the switch where to route the call. The server's processing power lets it screen and route incoming calls. For example, caller-ID information may help route the call to the proper person. Third-party call control is particularly helpful in workgroups and call centers.

But the server-centric model manages only call control. The switch-to-server link is for status and requests only. It doesn't carry the voice path and in no way physically connects a phone line to the server. For a server to send and receive faxes and data, a physical phone line would have to be connected to a fax-modem board in the server.

Voice-server systems are a variation on the server-centric model. Where server-centric systems deliver call-control links but not the calls themselves, voice-server systems deliver the calls directly, but not a separate control-and-status link.

In a voice-server model, phone lines from the switch connect to a board in the voice server. Depending on the board's capabilities, the lines can be analog, ISDN, or proprietary digital. The board can do anything that the phone it replaces can do; for example, it can issue a flash hook to transfer, conference, hold, call park, call forward, initiate call pickup from another office, and so forth. Digital phones usually have other features, such as speakerphone control and caller-ID display.

With the phone line going into a voice server, you get the media—that is, the voice path, or the data path for faxes and modem calls—but you don't get all the information and control that's available on the server-centric model. For example, a phone line can't force the switch to take control of another call; it can only control a call that it has received or placed. It can't tell the switch to forward a call from the next office to another phone.

In a server-centric call-center application, the server receives the caller ID and tells the switch where to send the call. In the voice-server model, on the other hand, the call is sent to the server, which must then answer it and transfer the call. But this is just too slow for a call center.

PC-centric systems have the telephone line and the telephone itself connected directly to an add-in board in the PC. The telephony board emulates the type of telephone that the switch is designed to support, whether analog or proprietary digital.

When we have isochronous Ethernet or

Strategic Industry Alliances

Versit

An important alliance is Versit, formed by Apple, AT&T, IBM, and Siemens in 1994. It aims to define a comprehensive solution, enabling the development of configuration-independent CTI applications that work in direct-connect or client/server configurations.

Versit will support PDAs (personal digital assistants), personal computers, pay phones, proprietary digital phones, and servers. The planned *Versit CTI Encyclopedia* will define terminology, configurations, feature sets, call flows, protocols, the Versit TSAPI (Telephony Server API) procedural API, and object classes.

In June, Versit released its first specifications on the World Wide Web (www.versit.com).

ECTF

In April, Dialogic, Digital Equipment, Ericsson Business Networks, Hewlett-Packard, and Northern Telecom formed the ECTF (Enterprise Computer Telephony Forum) to promote an open, competitive market for CTI. ECTF is the first consortium of end users, vendors, systems integrators, and software developers to work toward implementing CTI based on international standards.

ECTF will promote implementations for CTI elements and will also deal with both call-control and media-stream-processing issues. The forum will not select or promote specific CTI technologies (as Versit has), but it will work toward interoperability among standards and technologies.

ECMA/CSTA

The ECMA (European Computer Manufacturers Association) has formulated a standard, called CSTA (Computer-Supported Telephony Applicatons), to enable computers and telephone systems to communicate.

But CSTA is not an API—it's a communications protocol specifying how to make the connection between a phone switch and a computer. "The problem," according to Dialogic's Carl Strathmeyer, "is that while switch vendors all claim to support the CSTA standard feature set, they all implement them differently." For example, the `transfer` command might mean one function for one vendor's CTI product but trigger a different response from another vendor's system.

ATM (asynchronous transfer mode) data pipes going directly into our PCs, which looks to be the long-term prospect, we'll use PC-centric telephony systems. For the shorter term, however, we'll see fax-modem boards with telephony features that will provide an interim solution.

TAPI Dancing

Beyond network configuration, there are issues of APIs to iron out before you can point and click your way through the phone network. Two leading APIs (Microsoft/Intel's TAPI and AT&T/Novell's TSAPI), plus an emerging technology (Tmap from Nortel, formerly Northern Telecom), are designed to bring them together.

The most widely known current standard is TAPI (Telephony API). Developed by Intel and Microsoft to support both client and server telephony, TAPI's key attributes are its tight integration with Windows, support for coexisting multiple applications, telephone network independence, support for all the different CTI configurations, and access to the information carried over the telephone line. Of course, it can also dial, forward, transfer, and perform other signaling operations. TAPI supports a wide variety of telephone networks, including PSTN (the Public Switched Telephone Network), PBXes, ISDN, cellular, and Centrex.

Besides supplying support for first- and third-party call control, TAPI provides a software interface for accessing media streams (i.e., the information carried end-to-end over the telephone network). This means TAPI can support applications such as answering machines, voice mail, conferencing, faxes, voice recognition, and data. TAPI also supports a wide range of telephone-switching equipment, such as legacy PBXes, voice servers, and PC-based switches, as well as a variety of network connections, including isochronous LANs and ATM networks.

To date, TAPI has been implemented on Windows 3.1 and Windows 95. Microsoft has announced the TAPI implementation for Windows NT, which will allow suitably equipped NT machines to be computer-telephony clients (for the end user) or telephony servers on a network. TAPI allows desktop PCs to be either physically connected clients of a switch system or logically connected software clients of a Windows NT server.

So, if the phone and PC are physically connected at the desktop with, say, a Comdial TAPI adapter, TAPI interfaces between the Windows application and the Comdial hardware. In a server environment, TAPI interfaces with the server application running in the NT server.

This is where Microsoft and TAPI have a big edge over TSAPI—tight integration into the desktop PC's OS, combined with tight integration into the server OS. This is a big win for developers because they can easily port their software from first-party to third-party applications.

"Since TAPI is a standard part of the Windows family, developers and customers don't have to pay extra or try to figure out how to install a bunch of plumbing to enable their applications," says Charles Fitzgerald, a product manager in Microsoft's Personal Systems Division.

TSAPI, Anyone?

TAPI's main competitor, TSAPI (Telephony Server API), was developed by AT&T and Novell. TSAPI is an API for call control, call/device monitoring and query, call routing, and device/system maintenance for workgroups on a NetWare network. It integrates NetWare services with the functionality of a telephone PBX.

TSAPI uses the link between the PBX and the NetWare file server to create a logical connection at the workstation between the individual phone set and the desktop computer. This link enables an application to deliver the full capabilities of the phone system, control calls from either end of the call, or give a third party complete call-control and monitoring abilities.

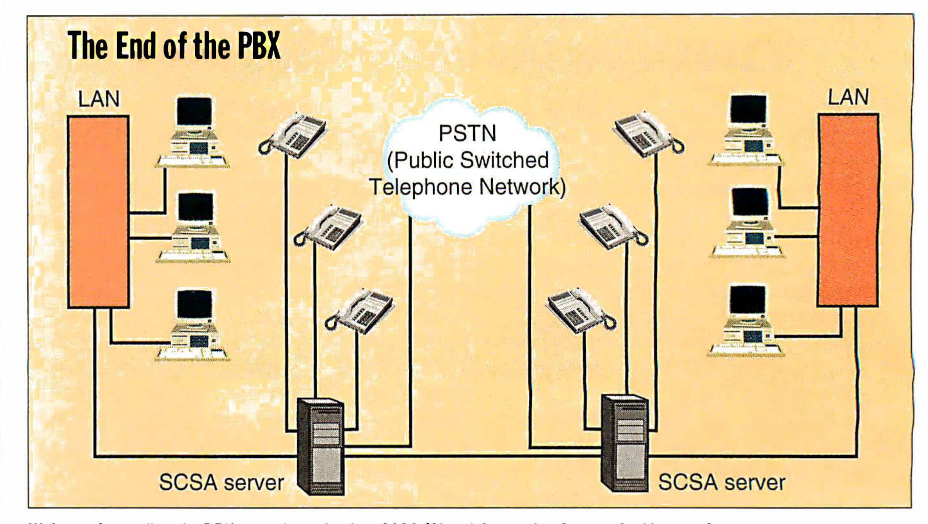
Using TSAPI, many software developers are delivering client/server applications that provide desktop dialing, visual voice mail, integrated messaging (i.e., fax, voice mail, and E-mail), conference-call bridging, sales-call restriction, and data/call synchronization. For example, the NetWare Telephony Services product from Novell is designed to provide easy server-based administration of a CTI environment. It also enables applications to generate usage reports, as well as access and share central network databases.

However, TSAPI has a problem: It does not provide media access—that is, it does not provide a physical connection between the PC and the phone. Consider this scenario: A fax call comes in. Because TAPI accesses the call directly, it's smart enough to recognize a fax tone and can automatically transfer the call to a designated fax application on the user's PC.

A TSAPI-based server, however, would have no direct way of knowing what kind of call it is. It might, perhaps, recognize the calling phone number as a fax line that it already knows about. But even then, it can't transfer the call directly; it has to instruct the switch to do so.

TSAPI's designers evidently assumed that only call control really mattered. Now they're playing catch-up. Versit, an industry consortium (see the text box "Strate-

 Standard Issue



We'll say farewell to the PBX as we know it when SCSA (Signal Computing System Architecture) servers on our networks are linked to each other and to the telephone company's central office.

gic Industry Alliances" on page 203), has adopted TSAPI as a cornerstone of its CTI solution and says it will develop extensions to handle media-control services.

A wide range of PBX companies and ISVs (independent software vendors) support TSAPI. Many PBX manufacturers in the U.S., Europe, and Japan—including Alcitel, AT&T, Comdial, Ericsson, Fujitsu, Mitel, NEC, Nortel, and Siemens/ROLM—have committed to developing NetWare drivers for their PBXes.

TSAPI supplies support for multiple desktop OSes, including OS/2, Windows, UnixWare, and the Mac OS. In addition, Versit has announced that it will extend TSAPI support to include Windows NT.

Tmap Ties APIs

With the CTI world choosing sides, users need a bridge to unite the two main telephony APIs. Tmap provides that link between TAPI and TSAPI, and it has been adopted by the ECTF (Enterprise Computer Telephony Forum). Tmap was developed by Nortel, which worked closely with Intel and received support from both Microsoft and Novell.

Tmap enables TAPI-based applications to work with PBX systems designed to support TSAPI. By translating TAPI programming calls to TSAPI requests, Tmap also lets TAPI-compatible desktop applications run on networks using NetWare Telephony Services. Developers can now build applications for the universal Windows client, which enables users to use whatever back-end server they choose.

Susan King, director of CTI at Nortel, explains that the company "created Tmap with the intention of easing developer confusion and has made it available to the industry free of charge."

Extending Tmap to the ECTF umbrella was a natural extension, and the ECTF will be able to define Tmap's evolution based on input from multiple vendors, which should ensure its viability in the marketplace. King notes that Nortel "has agreed to evolve Tmap based on the ECTF specifications and future iterations of TSAPI and TAPI."

Bringing in Resources

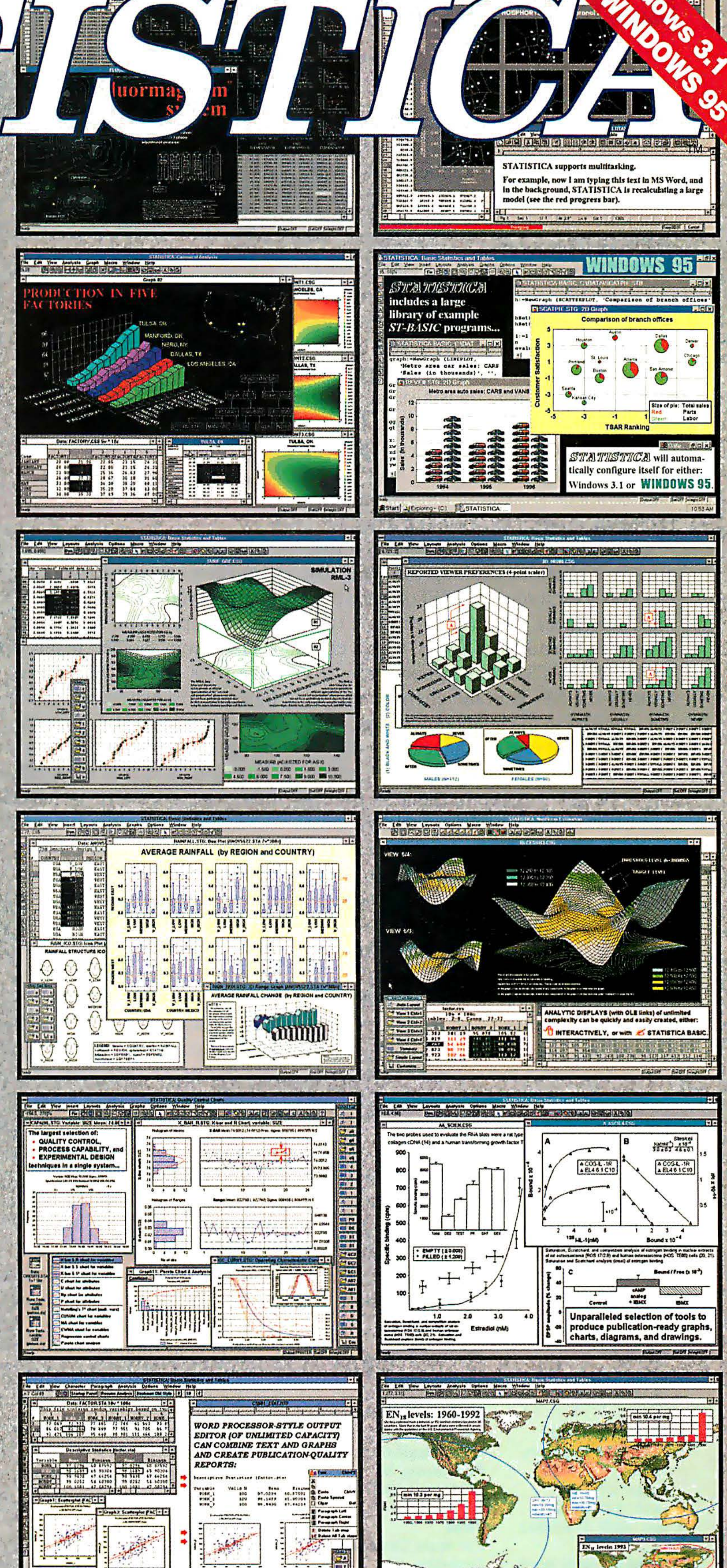
The real bottleneck in cross-platform interoperability is not the API but the lack of a resource model for the API to call. Every switch vendor implements a different model for each telephony command. Two different models are vying to become an architectural standard.

SCSA (Signal Computing System Architecture) is an industry initiative started by Dialogic and now supported by more than 260 companies. SCSA is a comprehensive hardware and software architecture for building call-processing systems with multiple technologies and standard interfaces. The architecture covers many facets of system design, from low-level bus and hardware interfaces to high-level software APIs.

With SCSA, developers can integrate multivendor components within standard PCs or larger computer systems using the VME bus, which enables them to create computer-telephony systems ranging from medium to very large in size. The hardware-independent SCSA software model is compatible with TAPI and TSAPI.

The SCSA TAO (Telephony Application Object) Framework is the software

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portion of SCSA. This object-oriented architecture provides an open infrastructure that lets independent applications share a pool of discrete telephony resources—generally, call channels and data-stream-processing resources.

This is particularly important because one of the big issues (and common requirements) of telephony is real-time transmission. Computer-telephony resources require more complex resource management than does simple data transmission, which can often tolerate minor delays. This is comparable to a conversation stopping in midword and your having to wait for an indeterminate amount of time for another packet of wisdom to finish the word.

Client applications to a TAO server running in a client or desktop PC typically call the server through an SPI (service provider interface), which converts one type of service to another. (Tmap, which converts TAPI to TSAPI, is a good example.) Usually the SPI is in the client software, but it can be in the telephony server.

An SCSA server can have many different operations and calls going on, and it has to be able to support them all in real time to avoid annoying delays; this is known as *dynamic resource sharing*. For example, say two calls come into an SCSA server at once. One caller uses an interactive voice-response system to retrieve data from a database linked to the server, while the second caller requests a fax back.

The SCSA server needs to handle both calls simultaneously. And it has to be able to hand off the fax call for data-stream processing when the second caller sends the appropriate command (and has turned on his or her fax machine).

The model makes it simple for an application to pass call-data streams between different processing resources (e.g., recorders, recognizers, and phone ports) and also between applications. This allows, for example, an E-mail message to become a database query or another transaction.

A Checklist for Making CTI Decisions

With the maze of technologies, products, and standards to choose from, what are you to do when faced with designing a system or picking components? Consider the following issues when choosing a CTI (computer telephony integration) platform:

- **Flexibility of the network.** Is it compatible with TCP/IP, IPX/SPX, and NetBEUI?
- **Applications.** Is the environment robust enough for multimedia and telephony applications development?
- **Multitasking.** Does the environment allow for multiple and simultaneous functions to avoid putting calls on hold?
- **Reliability.** Is the environment stable enough to ensure that a mission-critical application, such as call control, won't crash?
- **Open design.** Is the API compatible with a wide range of PBX systems?
- **Media stream.** Will the environment handle multiple media devices, including fax, data, voice, and video equipment?
- **Pricing.** Is the API bundled with a comprehensive operating environment?
- **Scalability.** Does the environment support a range of form factors, platforms, and multimedia applications, as well as high-volume user traffic?

SCbus (a part of the SCSA initiative) also allows servers to work together more easily. If you have multiple SCSA servers, for example, one server may need resources from another. In this situation, the time slots of the two servers aren't contiguous, so a *hyperchannel* is used to give one server access to a time slot in another server. SCbus supports this bundling of time slots, which is especially useful for transmitting services such as video.

"SCSA solves the fundamental problem in CTI today—developing a common resource model," comments Carl Strathmeyer, director of marketing at Dialogic and chairman of the CTI trade association ACTAS (Alliance of Computer-Based Telephony Application Suppliers). "Until now, developers would have to modify their software to work with each switch vendor's resource specifications. With SCSA and the ECTF, it's very encouraging to see industry vendors finally agreeing to a single open architecture that software and telephone-equipment vendors can build around in total confidence."

Green with MVIP

An older alternative to the SCSA hardware platform is MVIP (Multivendor Integration Protocol), which is another digital auxiliary bus. The SCSA TAO software environment supports both.

MVIP is based on the Mitel ST bus reference design and was defined in 1990. It's a bus developed for use in computer-telephony servers as well as to allow videoconferencing workstations to hop from an ISDN or T1 adapter card to an H.320 videoconferencing codec.

MVIP uses a distributed switching model that's similar to modern PBX architectures and makes software development easy, and bandwidth and CPU utilization highly efficient. (However, SCbus offers even more bandwidth than MVIP.) It's used in telephony servers and for distributed computer-telephony systems.

If It's Plug-and-Play, Whose Plug?

Besides a software API and architectural platform, CTI needs a standard mechanism for connecting peripheral devices. The RJ-11 phone jack can't carry the load, and the RS-232 serial port is too cumbersome. To address these limitations, two new contenders have emerged: USB (universal serial bus) and GeoPort. Both will be used in phone-centric designs, because the phone line connects to an adapter or to a phone with a built-in interface.

USB was jointly developed by Compaq, Digital Equipment, IBM, Intel, Microsoft, NEC, and Nortel. It has a multidrop interface and uses a single connector for phones, modems, keyboards, mice, game ports, serial devices, digital audio, printers, and scanners. It has a built-in port for connecting to PBXes, ISDN lines, Centrex systems, and even POTS (the industry acronym for "plain old telephone service"). With the vendor support that it has, USB will become a standard feature on most PCs by mid-1996.

The USB specification will simplify and improve the performance of PC-to-peripheral and PC-to-telephony applications. It will bring support for new computer-telephony integration capabilities—communicating mixed-media information, including sound, images, and data—and will eliminate the need for special add-in telephony connections.

USB runs at 12 Mbps, compared to the standard PC serial port's speed of 115 Kbps. It also offers isochronous and asynchronous data transfer, a star-hub architecture that allows a single PC-port con-

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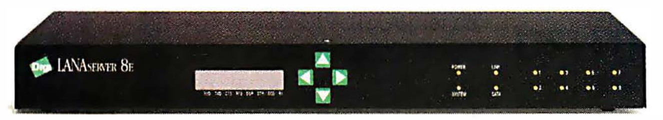
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troller to link up to 63 digital peripherals, and automatic recognition and configuration of external USB-based peripherals.

GeoPort, the other contender, is Apple's point-to-point interface. It supports phone/PC connection, as well as devices such as Apple's digital camera. In a CTI architecture, GeoPort provides the connection between the PC and the phone, as well as a flexible means of attaching peripherals via a single, compact, mini-DIN connector.

GeoPort is a cross-platform interface that delivers voice, data, audio, and video communications over any analog (POTS) or digital (PBX or ISDN) telephone line to a PC. It provides a flexible, scalable architecture for multiplexing several dozen simultaneous data streams, such as the 24 channels found in an ISDN primary-rate interface.

Versit opted for Apple's GeoPort architecture, which allows isochronous communications as fast as 2 Mbps. The Versit GeoPort provides up to 200 times the bandwidth of traditional serial ports.

Bye-Bye, PBX

We believe the recipe for a successful CTI system will likely include the following:

- Architecture: SCSA
- API: TAPI (for some NetWare users, the Versit version of TSAPI)
- PC operating environment: Windows NT for mission-critical CTI applications
- Physical interface: USB

The future of CTI will consist of departmental and workgroup solutions where SCSA-based servers operate behind existing switch systems. The trend toward increasing intelligence in call control will result in a platform-independent API that will enable cost-effective applications development. The next step will put the switching technology into the PC server.

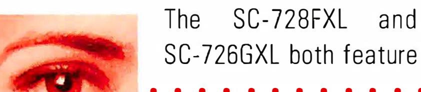
Emerging CTI applications are transport-independent—they don't rely on the underlying switch architecture. Once we arrive at the stage where the phone is just another part of the PC, transport-independent CTI applications are running over isochronous Ethernet or ATM, and SCSA servers are connected directly to the PSTN, we can finally say good-bye, once and for all, to proprietary PBXes. ■

James Burton is the CEO of C-T Link, Inc., in Boston, Massachusetts. You can reach him on the Internet at jburton@internetmci.com or on BIX c/o "editors."

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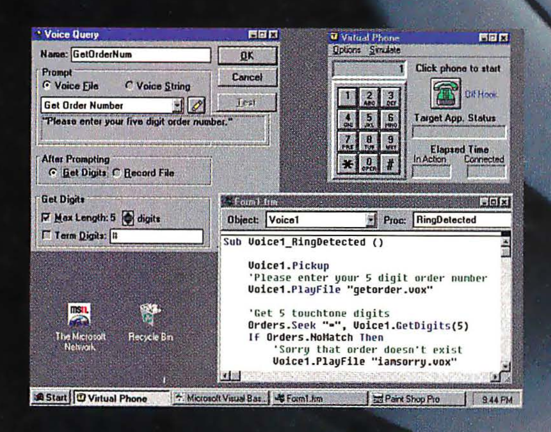
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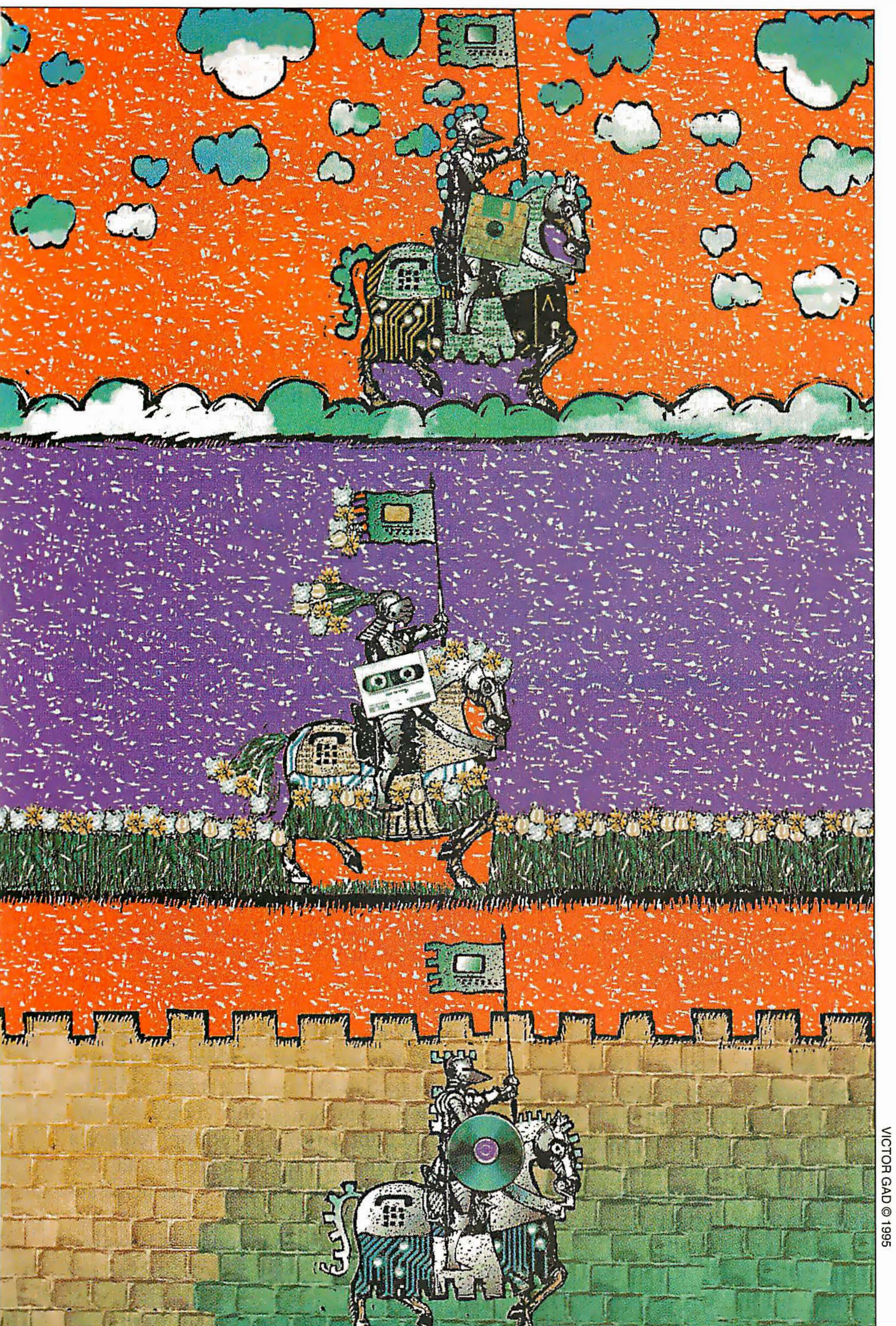
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BUILDING TELEPHONY APPLICATIONS

Dozens of development tools, many based on Visual Basic, can help you create a voice-processing system

JAMES BURTON



VICTOR GAD © 1995

"Press 1 to speak with a sales representative. Press 2 to reach technical support. Press 3 to listen to some lovely Muzak...." We've all had firsthand experience with infuriating voice-menu systems that drone on and on with options we don't want to hear. But that's not a fair summary of what computer telephony is all about. Modern, well-designed telephony applications can do much for an organization—and for those who call it.

What is a telephony application? At its simplest, it's the automation of the handling of telephone calls: answering the phone, greeting the caller, and responding to a request—all without a human operator. As it grows more complex, it incorporates many other functions, including digit capture, storing and forwarding of voice messages, database access, automatic speech recognition, text-to-speech conversion, storing and forwarding of fax data, fax response, dialing out, and tracking usage statistics.

So far, the most successful voice-processing applications automate existing manual functions. These usually show a rapid, measurable payback. This is probably a transitional stage, however. It reflects the relative newness of CTI (computer telephony integration). As more organizations create a wider variety of applications, we will begin to better understand how CTI can serve us. In a few years, we'll be using applications that we haven't even thought of now. As more organizations use telephony, those that don't may be at a competitive disadvantage.

It's Not Just New Software

While most of us think of applications primarily in terms of software, it's important to factor in hardware when you're dealing with telephony. The profusion of telephony standards (see the article "Standard Issue" on page 201) means that you must know what hardware you're going to run

your telephony application on before you create it—and even before you pick a development tool or environment.

In addition to the hardware you'll run your application on, consider the external hardware and software you'll connect to. Look at the interface to the telephone system and the external database. What kind of PBX do you have? What kind of phone lines link you to your local telephone company's central office? What other services are available? You may have analog or digital line options. Switching and information services, such as DID (direct inward dialing) and caller ID (widely but not universally available), are important to know about at the beginning.

In addition to selecting the appropriate services, you need to make sure that the voice-processing boards and the applications generator support those services. Also, it's important to know how many telephone ports you'll need. You can determine this by estimating the telephone traffic during the busiest hour of the day and deciding on the quality of service you need. Then you can consult telephony traffic tables to find out just how many ports you'll need. If you're connecting to the telephone network through a PBX, the same basic considerations are required, although you may find yourself constrained by the services and capacities your PBX will support.

One last external factor you need to consider is any existing databases—customers or orders, for example—you will use with the telephony application. You'll want to pick a development tool that integrates easily with your database and gives reliable access to the information you need.

Sitting Pretty

The Henredon Furniture Company (Morganton, NC) had seven customer-service representatives, each struggling to handle 150 dealer inquiries a day about stock availability. The volume of calls meant that many callers were getting busy signals. Others were put on hold for extended periods. West Coast dealers were especially upset because customer service ran on East Coast hours, which made late-afternoon and weekend inquiries virtually impossible.

To help spread the load, Henredon used Ease from Expert Systems (Atlanta, GA) to implement an interactive voice-response inquiry system. This enabled dealers to find out about such things as case goods, fabrics, upholstery frames, product availability, order status, and other sales data.

The voice-response system handles 480 calls per day and generates 11,000 transactions. The high availability of the system is another major benefit. Since installing the system, Henredon has added fax-response capability so that dealers receive a hard copy of order status and inventory information.

Telephone-Taming Toolkits

OK, you've opted to go the computer telephony route, and you've got an idea of the hardware and other software you'll connect to, so what's next? A variety of development tools is available, ranging from simple programming libraries through telephony utilities to comprehensive applications generators.

These tools assist in building telephony applications for a variety of operating environments and with a variety of programming methodologies. The table "Applications Generators for Telephony" on page 213 gives summary information about many toolkits. Some have the ability to implement or integrate with voice mail, fax processing, speech recognition, text-to-speech converters, telephony switching (e.g., conferencing and call forwarding), and data communications capabilities. As with any software project, good tools can cut the development time and cost substantially. They often enable organizations to build their own applications rather than seeking outside help (see the text box "How Much Will It Cost?" on page 214).

Calling Dr. Blue

Brigham and Women's Hospital (Boston, MA) has made a major commitment to computer telephony. Using the Visual Voice applications generator from Stylus Innovation (Cambridge, MA), it has implemented five voice-processing applications. According to technology planner Pashe Roberts, the hospital environment, with its small departments, creates the need for many small-scale voice-processing applications.

The five applications at Brigham and Women's cover a variety of functions and areas. One lets nurses call in and report a specific environmental problem and its location. With another one, expectant mothers can register for childbirth classes. A third application aids the hospital's telecommunications technicians. They can test the quality of a phone line by calling into the system and recording a message; the system calls them back, and they can listen to their message. The fourth application lets a centralized monitor provide audible information, via telephone, about the operational status of the client/server network. With the latest application, HMO subscribers can verify referral numbers.

One big reason the hospital selected Visual Voice was that Visual Basic was already used extensively within the hospital. The hospital had developed a special Visual Basic driver to tap into one of its primary database systems, one written in MUMPS.

The hospital plans to add new telephony applications. Among the projects it will undertake are desktop telephony using TAPI (telephony API), plus text-to-speech and speech-recognition systems.

Picking the Right Tool

All these tools aren't designed to do the same job. The right voice-processing applications generator is the one that best matches your experience and skills and the needs of a specific application. Most vendors are offering or planning multiple products that support multiple methods. Among the factors you should consider are the programming skills of your developers, what platforms you want to use, what telephony features you plan to use in your application, and the quality of support provided by the vendor.

Menu-driven or script-based? If some or all of the development will be done by people with little programming experience, it makes sense to pick a menu-driven product. With these, you construct your application by connecting specific functions—for example, answer phone, play prompt, or get digits—which are commonly referred to as actions. Governing each action is a set of parameters that is presented to the user in a menu, typically giving defaults and other choices. Menu-based applications generators require a minimum learning investment, and they are useful when you need to create an application rapidly.

If the application is complex, however,

APPLICATIONS GENERATORS FOR TELEPHONY

VENDOR	PRODUCT NAME	PLATFORM	PROGRAMMING INTERFACE	PRICE OF DEVELOPERS KIT—MINIMUM/FULL CONFIGURATION	PRICE OF RUN-TIME FOR 4 / 8 / 16 / 24 / 48 TELEPHONE PORTS	INQUIRY NUMBER
Apex Voice Communications, Sherman Oaks, CA, (800) 727-3970 or (818) 379-8400	**OmniVox**	Unix	❑	$2400 / $5600	$1400 / $2800 / $5600 / $8400 / $16,800	1238
Big Sky Technologies, San Diego, CA, (800)736-2751 or (619) 496-2100; fax (619) 565-2114	**Remark**	OS/2	❑	$6364 / $6364	$23,164 / $45,564 / $90,364 / $135,164 / —	1239
Cascade Technologies, Inc., New York, NY, (212) 768-7380	**CAS Voice**	OS/2	❑	$2300 / $19,320	$1150 / $2070 / $2760 / — / —	1240
CTI Information Services, Reston, VA, (703) 648-1610; fax (703) 648-1678	**Apprentice**	Unix	☛	$6500	Varies	1241
Cypress Research, Sunnyvale, CA, (408) 752-2700; fax (408) 752-2735	**PhonePro**	AppleTalk	❑ ☛	$349 / $849	$199–$548 per port	1242
Edify, Santa Clara, CA , (800) 944-0056 or(408) 982-2000	**Electronic WorkForce**	OS/2	❑ ☛	$11,400 / $13,100	$7800 / $15,600 / $31,200 / $46,000 / $86,520	1243
Expert Systems, Atlanta, GA, (404) 642-7575	**Ease 3.0**	MS-DOS	❑ ☛	$695 / $16,295	$495 / $945 / $1245 / $1445 / $2045	1244
IBM, Research Triangle Park, NC, (800) 426-4211	**CallPath DirectTalk/2**	OS/2	❑	$4000 / $11,800	$4000 / $8000 / $16,000 / $24,000 / $48,000	1245
Info Systems, Toronto, Ontario, Canada, (800)825-5434 or (416) 665-7638; fax (716) 855-2244	**Talkie**	MS-DOS	❑ ☛	$715	$100 perport	1246
Intelligent Computer Technology, Norcross, GA, (800) 441-9077 or (404) 441-9077; fax (404) 441-2727	**PhoneLink**	Windows	✐	$729 (includes card) / $1745	$2695 / (hardware add-ons above 4)	1247
ITI Logiciel, Montreal, Quebec, Canada, (514) 597-1692; fax (514) 526-2362	**Multi-Voice**	MS-DOS	✐	$149/ $599	None	1248
International Voice Systems, Hamden, CT, (203) 288-4461; fax (203) 288-4552	**Insight**	OS/2	❑	$3740 / $7084	$1870 / $2618 / $3368 / $3740 / $4488	1249
KDS Corp., Wilmette, IL, (708) 251-2621; fax (708) 251-6489	**Vox**	MS-DOS, OS/2	✐	$15,000 (includes five run times)	0 / $600 / $1350 / $2450 / $6650	1250
MasterMind Technologies, Vienna, VA, (703) 848-9040	**MasterVox**	OS/2	❑	$1995/ $3185	$400 / $800 / $1600 / $2400 / —	1251
MediaSoft Telecom, Montreal, Quebec, Canada, (800) 558-3839 or (514) 731-3838; fax (514) 731-3833	**IVS Builder/ Server**	Unix	❑ ☛	$950	$1980 / $3680 / $5060 / $9200 / $17, 520	1252
Parity Software Development, San Francisco, CA, (415) 989-0330; fax (415) 989-0441	**Vos**	MS-DOS	✐	$1885/ $20,350	$660 / $1320 / $2640 / $3960 / $7920	1253
PCVoice, Roswell, GA, (800) 443-8201 or (404) 343-8201; fax (404) 442-3156	**Assist Pro/FP**	Windows	✔	$325 / $449	None	1254
Pronexus, Carp, Ontario, Canada, (613) 839-0033; fax (613) 839-0035	**VBVoice**	Windows/ Visual Basic	✐	$395	$995 / $1295 / $1695 / (32) $1995	1255
SpeechSoft, Ringoes, NJ, (609) 466-1100 fax (609) 466-0757	**Speech Master**	MS-DOS	✐	$595 / $3144	$895 / $1145 / $1395 / $1395 / —	1256
Stylus Innovation, Cambridge, MA, (617) 621-9545; fax (617) 621-7862	**Visual Voice**	Windows/ Visual Basic	✐	$495 / $2785	None	1257
Talking Technology, Alameda, CA, (510) 522-3800; fax (510) 522-5556	**Peak Toolkit**	MS-DOS, Windows	✐	$399	None	1258
Technically Speaking, Southborough, MA, (508) 229-7777; fax (508) 229-8777	**Show N Tel**	OS/2	❑ ☛/✐	$995 / $7000	$700 / $1400 / $2800 / $5160 / $12,240	1259
Telephone Response Technologies, Roseville, CA, (916) 784-7777	**ProVide**	MS-DOS, Windows 3.1/ Visual Basic	❑ / ✐	$723 / $12,352	$1145 / $2145 / $3455 / $4069 / $5845	1260
U.S. Telecom International, Joplin, MO, (800) 835-7788 or (417) 781-7000; fax (417) 623-2963	**Val**	MS-DOS	✐	$1995 / $1995	$600 / $1200 / $2300 / $3300 / $5700	1261
Voice Information Systems, Santa Monica, CA, (800) 234-8474 or (310) 392-8780	**VFedit**	MS-DOS	—	$395	None	1262
Voicetek Corp., Chelmsford, MA, (508) 250-9393	**Generations**	VAX/VMS, SunOS	❑ ☛	$18,000	$800 / $1600 / $3200 / $4800 / $9600	1263
Voysys, Fremont, CA,(800) 788-9797	**VoysAccess**	Windows 3.1	✐	$595 / $595	$495 / $990 / $1485 / $1980 / —	1264
Winters Development, Manti, UT, (801) 835-0100; fax (801) 835-0103	**VoiceKit**	MS-DOS	✐	$599	$599 / (12) $799 / (24) $999 / $2599	1265

a menu-driven applications generator may not have all the functions you need. Although many of them are comprehensive, they're limited to those features the vendor has decided to include. Connectivity is frequently the most limiting factor.

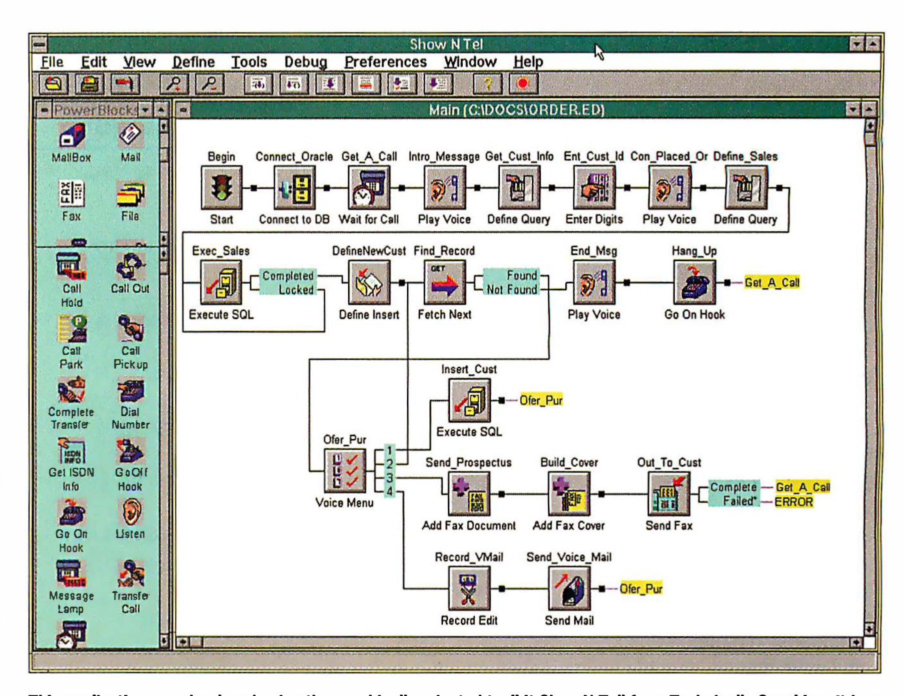
Consider, too, whether you want a tool that uses a graphical interface or a character-based interface. GUI-based applications generators appeal to the point-and-click oriented. As with many other visual programming tools, you build an application by connecting action icons together.

For organizations with in-house programming expertise, products using a scripting language will typically provide more flexibility to the developer than menu-based products. The price you'll pay is an increase in development and support times. Also, some vendors' menu-based and scripting-language products are compatible with each other, but others aren't. If this is important, check it out.

Consider whether you want your programmers to learn a new language, or whether you want to use one of the many popular voice-processing tools based on Visual Basic, such as Stylus Innovation's Visual Voice or Pronexus's VBVoice. Many applications generators also let you include your own C functions.

Processing platform. Most voice-processing development systems create applications for one operating environment. You should choose your platform and tool carefully. Windows 3.1 is an inferior multitasking OS, for example. For telephony systems that have many ports, or for critical-performance applications, DOS-based applications generators typically produce the best results. These systems don't actually use DOS as the run-time OS; instead, they rely on their own embedded OS, which is designed specifically for voice-processing applications and is extremely efficient.

The vendors that have been around the longest are Expert Systems, SpeechSoft, Telephone Response Technologies, and U.S. Telecom. Although all their products have improved, they're still essentially identical to what they were offering 10 years ago. For example, they still use DOS. Although there's significant pressure to migrate to other OSes, the reality is that DOS-based systems provide performance and capability that are comparable, or superior, to systems based on Windows 3.1, Unix, or OS/2, and they're less costly. ■



This application was developed using the graphically oriented toolkit Show N Tell from Technically Speaking. It is an order-verification system that includes interactive voice response, fax on demand, and database querying.

TAX MAN

Jackson Hewitt Tax Service (Virginia Beach, VA) issues loans secured by anticipated tax refunds. This year, the company generated $14 billion worth of refund checks, which generated many calls from banks to verify that it had issued the checks. Most of these calls came during a two-week period.

The company created an interactive voice-response system using the Provide applications generator from Telephone Response Technologies (Roseville, CA). The programmer, Lee Perkins, learned the package and set up the entire application in less than two weeks. He used the forms-based package rather than the scripting language, believing that the ease-of-use and support benefits of the forms-based product would outweigh the time needed to learn it. According to Perkins, TRT's documentation made the package easy to learn and use.

How Much Will It Cost?

The price tag on an applications development tool is only one part—and maybe a small part—of the final cost of your telephony application. Two other important considerations are run-time fees and how many telephone ports your system will use. To determine your true costs, you'll want to figure out your expenses on a per-port basis.

The price leaders are Stylus Innovation (with no run-time fees) and SpeechSoft, while Apex Voice Communications, Cascade Technologies, Expert Systems, MasterMind Technologies, Parity Software, Technically Speaking, Telephone Response Technologies, and U.S. Telecom are higher. The differences are smaller than they appear, however, because virtually all the vendors also sell voice-processing boards, and most bundle a board in their basic systems. If you need only a few ports, for example, you can get a starter kit from TRT, SpeechSoft, or U.S. Telecom for less than $1000. All kits include a Dialogic board.

Another difference is how options are priced. Most vendors have a laundry list of options, all priced extra. A few bundle everything in the basic product.

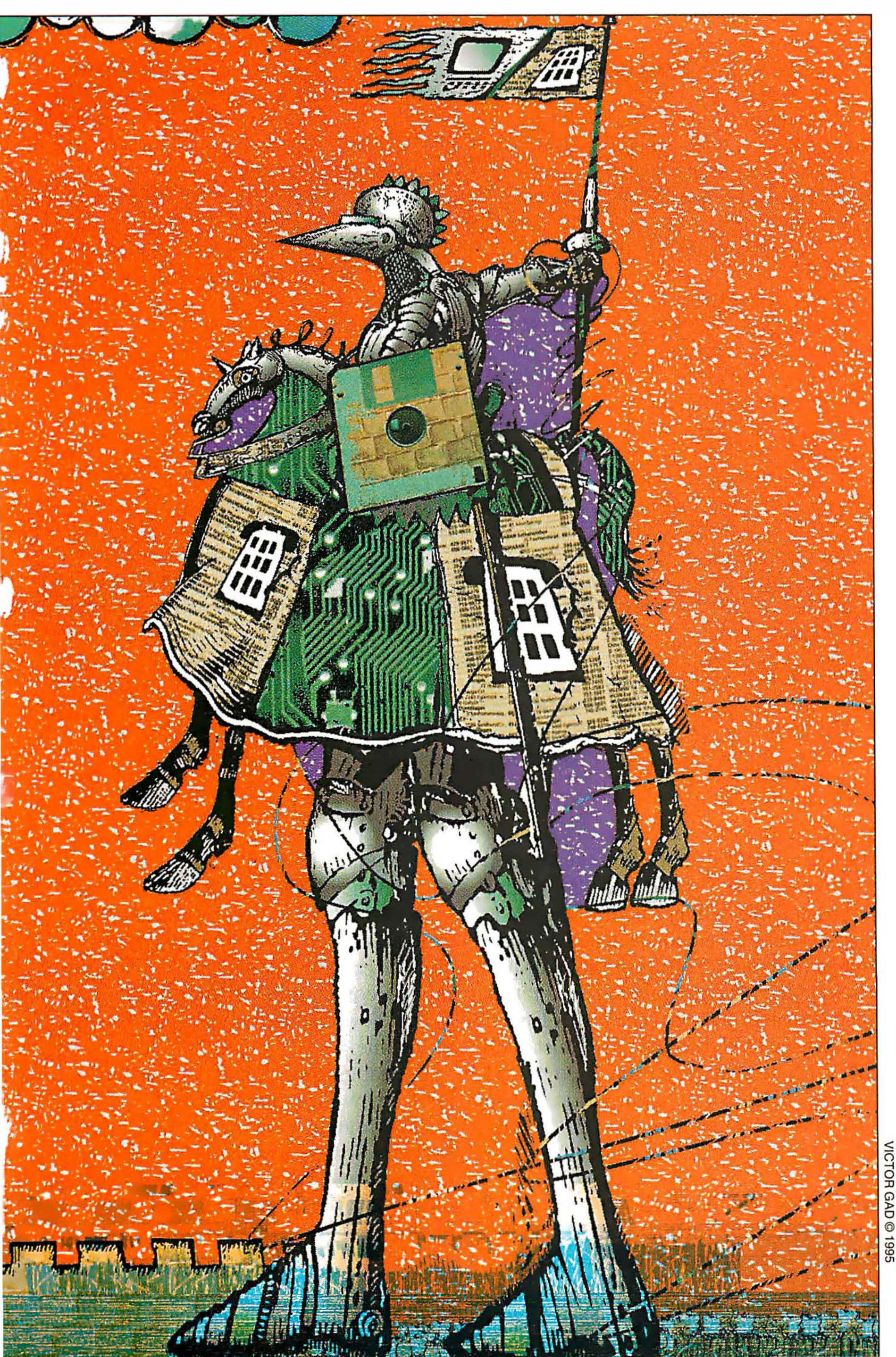
Voice-processing products from Edify, Big Sky, and Voicetek are at another level. These are expensive systems from total-solution suppliers. Consider them if you need a package that includes applications development, training, and ongoing support.

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TELEPHONY'S KILLER APP

It'll take an irresistible new application to make computer-telephony integration happen everywhere. Will one of these apps do it?

JOHN P. MELLO JR.



VICTOR GAD © 1995

We'll never look at telephones the same way again. New and innovative systems are tying the easy voice connections of the phone system to the data transfer and manipulation power of computer networks. The combination is extraordinarily seductive.

Over the next five years, we'll see our phones and computers transformed from separate boxes into a seamless entity that will integrate data and voice. Before this can happen, users have to want the change. What's likely to sell them on the idea is an application that captures the imagination and provides immediate productivity rewards—in other words, a killer app.

"The killer app revolves around new ways of doing telephony through intelligent computing," explains Ron Charnock, vice chairman of the Multimedia Telecommunications Association (Washington, D.C.). "It's thinking of telephony as a computing resource and less of a telecommunications resource."

A phone call will become a digital entity that can interact with other digital entities on our desktops and networks. It will carry contact information about its originator and trigger the assembly of data from computer files. It will become data itself and give our organizations crucial information about their operations.

No More Baffling Buttons

Current phone systems are a pain for most users, whose skill with advanced telephony features drops off drastically when they need to use more than the 12 buttons on the standard phone keypad. For those folks, the killer app will turn those incomprehensible extra phone buttons and multikey operations into friendly screen icons. "Businesses are spending anywhere from $100 to $1000 for these fancy business phone sets, and people don't use them," says David Goodtree, a senior analyst with Forrester Research (Cambridge, MA).

continued

"The killer app will replace those sets with $30 software that people will use."

Killer apps will integrate many diverse forms of messaging. Electronic mail will convert to voice mail, and voice mail to text. The system will read received faxes over the phone, and pager messages will become voice mail. "The killer app is any type of application that unifies your current business solutions with the telephony environment," notes Michael Durant, a senior product manager with Novell.

Does telephony's killer app exist now, or is it waiting to be invented? A number of new, powerful, and intriguing applications are already out there, and it's too early for the marketplace to render a verdict. Let's look at some of the contenders.

Phone, Take Notes

The killer network app may very well be PhoneNotes, telephony groupware from Lotus Development that sits on top of Notes. PhoneNotes supports applications that enable users to tap into a Notes database through a Touch-Tone phone. One such application, Mobile Mail, lets a user access, create, forward, or edit Notes documents and play documents over the phone through text-to-speech technology.

"One of the attractive features of Notes is the increase in productivity it gives you through greater mobility," explains Peter Klante, Lotus's director of marketing for Notes companion products. "This is a logical extension to that. It turns the most ubiquitous client in the world—the telephone—into a Notes client."

Data for Dialing

Some observers believe the guts of a killer app lie in the exchange of simple data. Versit, a joint development initiative by Apple, IBM, AT&T, and Siemens to develop CTI standards (see "Strategic Industry Alliances" on page 203), has laid the groundwork. One of those standards establishes a protocol for the exchange of electronic business cards. "This is really, really important and potentially a killer app," says Jerry Michalski, managing editor for the newsletter *Release 1.0*. "If every time people touch electronically, they can swap their latest contact information, they can suddenly communicate much more efficiently."

It will also eliminate what Michalski calls mode-switching friction—what you encounter when you try to mix media such as voice mail and E-mail with contacts outside your organization. Once these electronic calling cards become widespread, they can be a bridge between the desktop and the handset. When you check your voice mail, the calling card information is sent to your PC, and a screen pop displays the information. To return the call, just click on the phone number. You'd rather send E-mail? Click on the person's E-mail address. Fax? Web home page? Just click away. Mode-switching friction is reduced to zero. "The calling card protocol is so low-end and so simple you can do anything with it," Michalski contends.

It's Voice—No, It's Data

For this electronic calling-card idea to fly, it has to become easier to send data over ordinary phone lines. One promising development is a modem-based technology called VoiceView from Radish Communications Systems. VoiceView lets a user switch between voice and data transmission on an analog phone line, without losing his connection, as long as there's a VoiceView-enabled modem at both ends of the line.

Exchanging voice and data on one line isn't a new idea. Two years ago, MultiTech (Mounds View, MN) introduced a hardware/software product that allowed users to send voice and data simultaneously. But the MultiTech product was pricey, and the parallel approach caused some degradation of the voice portion of

Wildfire: One Wild and Not-So-Crazy Helper

One measure of a white-collar worker's status is often a personal secretary or executive assistant. A killer app may replace human helpers with an intelligent agent that would be totally digital. Wildfire Communications has incorporated this idea into a product called Wildfire, a HAL-like presence eavesdropping on every call you make.

What makes Wildfire such an exciting and powerful application, however, is that you don't need a computer to use it. You can link up with Wildfire from any phone, even a cellular or pay phone, or have it call you wherever you are. No matter where you are, you have full access to its capabilities.

You can tell Wildfire to sort your messages and play them back to you, or you can ask it to play a message from a sender by speaking his or her name. You can respond to a message immediately by simply saying the messenger's name or number. Wildfire will dial it for you, or send a message to the caller's pager. If you're on one call and receive another, Wildfire "whispers" the caller's name in your ear and lets you decide whether or not to interrupt your current call or relay a specific message to the new caller. It will schedule and remind you of follow-up calls, and it will forward calls to different numbers (cellular, hotel, home, etc.) based on your schedule. And Wildfire will let you prioritize contacts so it can screen your calls during hectic times.

During a Wildfire session, you call up the agent by simply saying "Wildfire" and pausing. Suddenly, a female voice announces "Here I am!"—the signal that Wildfire is waiting for your instructions. "It acts like a person you'd want to work with, as opposed to acting like a machine," says William J. Warner, CEO and founder of Wildfire Communications. "There are a lot of telephony applications that are Touch-Tone-based that act like machines. That's not what people want. They want to be able to talk to their assistant and get stuff done."

The software uses several speech-recognition technologies that add up to a natural, conversational feel for the user. For example, here's a typical Wildfire dialog for setting up a contact:

User: Wildfire.
Wildfire: Here I am.
User: Create a contact.
Wildfire: What kind?
User: Person.
Wildfire: What's the name?
User: John Mello.
Wildfire: Once more.
User: John Mello.
Wildfire: Which phone number should I add?
User: Work.
Wildfire: What's the number?
User: 555-1212.
Wildfire: Got it.

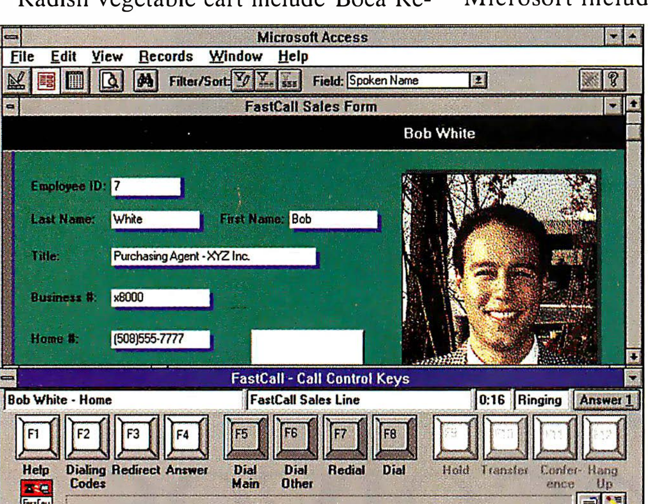
Wildfire uses discrete speech recognition to understand responses to its questions, such as what kind of contact and which phone number, because these responses are single words. When the user gives the new contact's name, however, the system uses trained speech because it needs to learn a new pattern. The system uses a speaker-independent continuous recognizer for numbers.

As impressive as Wildfire is, however, some industry insiders think it lacks one crucial component that a true CTI killer app needs: a seamless connection to what's happening inside the computer on the knowledge-worker's desk. Wildfire handles phone functions with elegance, but it doesn't connect to the data that's the lifeblood of an organization's operations, or to applications the worker may have running.

Wildfire runs on a dedicated server, a 90-MHz Pentium box with 128 MB of memory and 16 digital signal processors from Texas Instruments. Prices start at $50,000.

the call, so it didn't win wide acceptance. In contrast, VoiceView is inexpensive, doesn't degrade voice, and is being bundled with a number of modems.

Companies that have hopped on the Radish vegetable cart include Boca Research (Boca Raton, FL), U.S. Robotics (Skokie, IL), Hayes Microcomputer Products (Atlanta, GA), Diamond Technologies (Anaheim, CA), and Zoom Telephonics (Boston, MA). In addition, Microsoft includes driver support for VoiceView in Windows 95. Considering its support in Windows and the number of modem makers adopting Aurora's technology, industry pundits expect VoiceView to make a big splash in the market. Some analysts project that as many as 10 million modems will incorporate VoiceView by 1998.



Aurora Systems' FastCall endows Windows applications with telephony services. This screen shows a call-center telephony application. The program uses identification of incoming calls to trigger functions, such as popping up a contact record.

Launch My Apps

Another way to enhance the network pipe is through off-the-shelf middleware, such as FastCall from Aurora Systems. FastCall, which works with TAPI (telephony API) and TSAPI (telephony services API), endows almost any Windows application with telephony services, such as identification of incoming calls, creation of "screen pops" from customer records, and simulation of a phone's button functions on a computer display.

FastCall uses the identification of incoming calls to trigger functions selectively within Windows applications. For example, a call from a certain contact can be linked to a record in Lotus Organizer so when that contact calls, FastCall launches Organizer and pops the contact's record on the screen. Or the program can be trained to bring up a spreadsheet program or a personal finance manager when a bill collector calls. Or you can set it up to launch Tetris whenever a certain long-winded acquaintance calls.

FastCall has killer app potential because it works across a broad array of switching equipment, APIs, and applications, and it's transparent to the user. According to Paul Gasparro, CEO and cofounder of Au-

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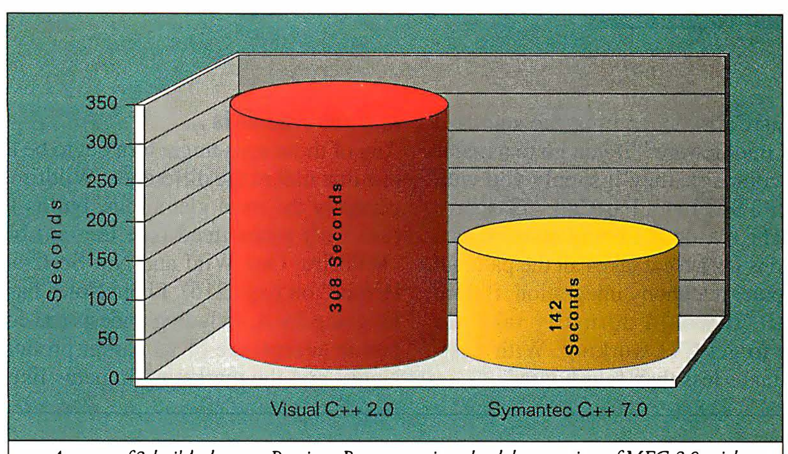
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Average of 3 builds done on Pentium Processor using the debug version of MFC 3.0 with VC++ 2.0 makefiles. Borland excluded due to lack of support for MFC.

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rora, FastCall is becoming the standard for CTI middleware. "If you go to a major switch company, they'll supply you with TAPI or TSAPI and FastCall," Gasparro says. "The reason it's being adopted as a standard is because it takes all the pain out of computer telephony integration. Before FastCall, it would normally take six months to get CTI working. With FastCall, it takes less than four hours."

And the Winner Is ...

Any of these apps might turn out to be the one that makes the difference. Wildfire is certainly the most glamorous, but its future isn't guaranteed (see the text box "Wildfire: One Wild and Not-So-Crazy Helper" on page 216). PhoneNotes has a lot going for it, including widespread corporate acceptance of its parent product, Notes, and the marketing impetus likely to result from IBM's takeover of Lotus. Either one could dramatically change our daily work habits. VoiceView is a less drastic step that is likely to open new doors for integrating data into our phone habits.

Or maybe the killer app will come from somewhere else. Novell's NetWare Telephony Services offers an attractive model for unified messaging, but its $15,000 price could keep it out of many organizations.

Whenever the killer telephony app arrives, however, one thing is certain: It will pay close attention to the human side of the technology equation.

"This is about social change, not just technology change," observes Michalski of *Release 1.0*. "CTI isn't about plugging a computer into a telephone. CTI is about making life easier for people who want to communicate." ■

John P. Mello Jr. is a freelance writer living in Woonsocket, Rhode Island. You can reach him on the Internet as JPMjr61750@aol.com or on BIX c/o "editors."

Product Information

FastCall .... $200-$600
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PhoneNotes Application Kit $695
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(617) 577-8500
fax: (617) 693-3512
http://www.lotus.com
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VoiceView
(bundled with compatible modems)
Radish Communication Systems
Boulder, CO
(800) RADISH8
(303) 443-5789
fax: (303) 443-1659
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Wildfire .... $50,000/24 users; $100,000/50 users
Wildfire Communications
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WEB SEARCH

JON UDELL

AL KARVEY © 1995

It's easy to index a Web document collection so visitors can search your site. Here are a couple of ways to do it.

Think the Web is too vast to search? I did, but index-and-search engines such as Carnegie Mellon University's Lycos (http://lycos.cs.cmu.edu/) and the University of Washington's WebCrawler (http://webcrawler.com/) proved me wrong. These robotic indexers ceaselessly read and catalog Web pages, and they have so far kept up remarkably well with the Web's explosive growth.

They take simple queries—a single term or several ANDed together—and return lists of URLs that could otherwise take you months of point-and-click navigation to assemble. They typically don't do proximity searches (word 1 within so many words of word 2). But InfoSeek (http://www.infoseek.com), a commercial service, does. And the WAIS Inc. server (http://www.wais.com) that powers a number of Web sites can even handle natural-language queries like What is the capital of Peru? For an example, see Encyclopedia Britannica at http://www.eb.com.

As good as Web search tools are, when you ask a specific question—How do I walk a directory tree in Perl? or What's the cheapest laser printer with network support for IP, IPX, and AppleTalk?—you likely won't find an answer in a hurry, and you may not find one at all. Brute-force searching, even at its best, yields hordes of false positives—documents that contain the keywords, even perhaps in close proximity, but have nothing to do with the question.

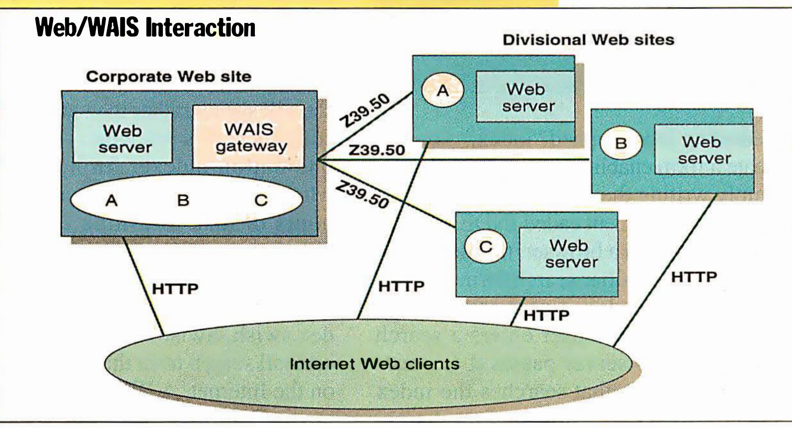
Information providers can help by categorizing documents, so users can look for how-to articles on Perl or reviews of network-ready laser printers. As we move BYTE's content into electronic media, we'll try to provide such clues. But will our categories match those used by other computer magazines? By book publishers? By people who post to Internet newsgroups? As the Web absorbs and extends the world's libraries, authors and editors will find that proper classification of their contributions to the Web will make those documents easier to find and, hence, more valuable. My advice to major Web contributors (and to creators of Web authoring tools) is to hire a library scientist.

What About WAIS?

WAIS (Wide Area Information Servers) predates the Web craze; since 1991, people have used its Z39.50 protocol to search a variety of databases on the Internet. Could WAIS clients bypass BYTE's Web server and search the collection directly? I found a pair of them (WinWais at ftp://ftp.einet.com and WaisMan3 at ftp://ftp.cnidr.org), started the WAIS service on my NT server, and pointed the clients at it. They worked. But so what? Hardly anybody uses WAIS clients because most WAIS databases have gateways that export Web-style access.

Still, a client/server protocol for searching remote databases ought to be useful. John Duhring, a WAIS Inc. vice president, showed me that it is. With WAIS tools, he says, Web providers can uniformly present information drawn from remote Web sites.

Consider The McGraw-Hill Companies, BYTE's parent. Many of its companies are building Web sites. With conventional Web technology, the corporate Web site can refer visitors to divisional sites—but they might never come back. If, on the other hand, BYTE and others run both Web and WAIS servers, and corporate runs both a Web server and a WAIS gateway (see the figure "Web/WAIS Interaction" below), the divisions can appear as players in corporate's virtual theater. Meanwhile, divisional Web sites accessed directly can retain their own flavor.



With a WAIS gateway, a central Web site can consolidate many remote sites into a single presentation.

Basic Indexing

While you're waiting for a Web equivalent of the Dewey decimal system, you might as well go ahead and add basic indexing to your Web site. Because we're running Windows NT, the EMWAC (European Microsoft Windows NT Academic Consortium) WAIS (Wide Area Information Servers) server and toolkit were the logical place to start. These tools are NT ports of freeWAIS; you can get

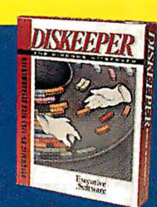
8.3 Brain Damage

If you're generating HTML mechanically, why not simply create long filenames, so that URLs themselves carry the information stashed in the HTML header (e.g., "January_1994/Reviews/Low-Cost_Laser_Printers.html")? That I didn't think of this at first shows the brain damage caused by years in the mental prison of the DOS 8.3 filename.

It's nice for URLs to be descriptive, but it's not necessary. What is essential is that they're unique and immutable. My scheme, which just enumerates sections and articles, guarantees uniqueness—there will be only one art\9401\sec9\art7.htm in the collection. But will that URL immutably refer to the January '94 review of laser printers? Not if we find that we've forgotten to include another January '94 article and then decide to regenerate the collection. Uh oh. Everything gets renumbered. This isn't a problem for Web site users because the navigation and search functions adjust to the new structure. But if you've saved a bookmark to art\9401\sec9\art7.htm, you'll be upset if I renumber the collection.

I'm not aware of gaps in the 1994 collection that's on the Web now, and I don't expect we'll need to renumber it. But I do want to try using descriptive URLs for 1995 and future content.

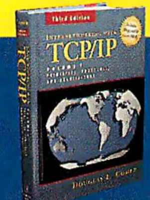




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BOOKNOTE



Internetworking with TCP/IP, 3rd edition, $52
by Douglas Comer
Prentice-Hall, 1995
ISBN 0-13-216987-8

Updated with new material on security, IPng, and ATM, Comer's lucid tutorial on Internet plumbing continues to top the charts.

Intel, Mips, and Alpha versions of them from various places including Microsoft (the Windows NT Resource Kit CD), EMWAC (http://emwac.ed.ac.uk or its mirror sites), and Process Software (http://www.process.com). Versions of freeWAIS for many Unixes are available from CNIDR (the Clearinghouse for Networked Information Discovery and Retrieval) at ftp://ftp.cnidr.org.

The tools come in two packages: wsXXX.zip for the WAIS server and wtXXX.zip for the WAIS toolkit. (Replace XXX with your CPU: i386, Mips, or Alpha.) I grabbed both programs from Process Software's site, thinking that I'd need the toolkit to create indexes and the server to access them. As it turned out, I really needed only the toolkit. It contains both the indexer and a query tool that searches an index and returns an HTML-formatted report listing URLs for documents matching the search. What's the WAIS server for? It enables WAIS clients to bypass your Web server and access your indexed document collection directly, using the WAIS Z39.50 protocol (see the text box "What About WAIS?" on page 223).

You'll need long filenames to use waisindex, the tool that does the indexing. Prior to NT 3.5, that meant you had to run it on an NTFS volume, but now that NT 3.5's FAT (file allocation table) supports long names that's no longer a problem. Here's the command I used to index the January 1994 issue of BYTE:

```
waisindex -d index -r -a -T html
art\9401\*.htm
```

where `-d` names the index, `-r` tells the indexer to recursively index subdirectories, and `-a` appends to an existing index. First time through I skipped the `-T html` option. When I searched the resulting index, what came back were filenames, not document titles. That meant the search results were cryptic references like "art\9401\sec9\art7.htm" instead of more helpful ones like "January 1994 / Reviews / Low-Cost Laser Printers."

Since the translator that creates our HTML files writes the latter style of reference in the <title> field of every article's HTML header, adding `-T html` was the quick fix. However, it prompted me to reconsider my sequentially generated URLs (see the text box "8.3 Brain Damage" above).

Once you've got the index built, it's a snap to connect Web clients to it. If you created an index named "index," you can create a form enabling users to search it by simply writing the keyword <isindex> in an HTML document called INDEX.HTM. When viewed in a browser, this document displays the familiar search form "This is a searchable index. Enter search keywords." When the user enters a search term, the Web server passes it to waislook, a program that searches the index and returns HTML-formatted results.

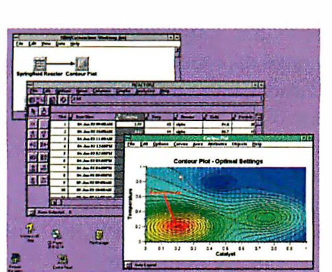
On a pair of NT boxes running EMWAC-derived Web servers—a 486 with Folio's Infobase Web Server, and an Alpha with Process Software's Purveyor—these procedures yielded the searchable archive that I'm currently testing. It works, but since multiple search terms combine with OR rather than AND, and there's no phrase search ("SQL catalog") or proximity search ("SQL within/5 catalog"), you depend on the selective power of a single term. An unusual one, like "PnP" or "Z39.50," will often net just the right bunch of articles; that's what makes even this bare-bones indexing system incredibly useful. But it's really just a minimal solution.

WebSite and SWISH

To improve matters on the 486 server, I turned to WebIndex, the tool that comes with O'Reilly & Associates' WebSite server for NT and Win 95. You launch WebIndex from WebSite's GUI administration tool, and it prompts you graphically for URLs to include in the index and begins indexing with a mouse click. Unlike waislook, WebSite's WebFind can at least join terms together with AND so that when you use multiple terms, the result set will shrink rather than grow. For small collections, it's just what it claims to be: a one-button indexer for non-nerds. But when I fed it several thousand documents, hours of disk thrashing ensued until I killed it.

What remained, from a previous run on fewer documents, was a file called index.swish. Swish? That's just the sort of oddball search term that gets great results on the Internet. A WebCrawler search led me to Enterprise Integration Technologies and the Simple Web Indexing

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The Road Traveled

In July's column we introduced a Web server on a dial-up PPP link, while awaiting installation of a 56-Kbps leased line. In August, we went live on the leased line, but the names www.byte.com and ftp.byte.com weren't hooked up yet. You could get to the server only if you knew its IP address. Now the names map to IP addresses, and we're officially open for business.

How did we register our name? We registered byte.com with the InterNIC (Internet Network Information Center) years ago and used it for UUCP (dial-up) mail routing. Once we got a real IP link to the Internet, there were three ways to create the names www.byte.com and ftp.byte.com and define their IP mappings:

1. Leave naming authority for byte.com in the hands of InterNIC and ask InterNIC to add our names to its database. (You do this by mailing a form to hostmaster@internic.net; the forms are available at ftp://rs.internic.net/templates.)
2. Delegate naming authority to our service provider MV Communications (again by mailing a form to hostmaster@internic.net) and ask MV to add the names to its database.
3. Take over naming authority ourselves.

The problem with 1 is that there's a big administrative backlog at InterNIC, so we opted for 2. We'll likely want additional names, and we won't want to wait two weeks for InterNIC to handle each request—MV's far more accessible to us. Why not 3? In that case, we'd have to run our own name server. We aren't ready to do that yet.

"The wait is about a week for change requests," said MV's Mark Mallet, "and two weeks for new records." He requested the transfer of byte.com's name service from InterNIC to MV. A week later it was done. The command `whois byte.com` listed MV's name servers, ping www.byte.com worked, and www.byte.com was open for business.

a

the mass market. "The optical industry in the past, except ...
ability to shoot itself in the foot. [PD] may be the way to break ...

The PD laser mechanism

image (15 Kbytes)

The PD laser mechanism is similar to that of a standard CD ...

b

The PD laser mechanism

Micro Optical Head

Phase-change disk
Movable unit
1/4 λ plate
Polarized hologram
Objective lens
Photo detector
Laser diode unit
Mirror
Collimator lens

The PD laser mechanism is similar to that of a standard CD-ROM dri...

In the BYTE collection, a link to an illustration reports the size of the image (a). Following the link leads not to a bare GIF file but to a document that wraps standard links, a headline, a caption, and a copyright notice around the image (b).

Magic Hot Links

When Netscape's news reader finds a string like http://www.somewhere.com in the text of a posting, it automatically converts that string into an active hypertext link. I've added this to BYTE's Web site with my Epsilon Extension Language translator. It's one regular-expression search-and-replace statement:

```
string_replace(
"((http|ftp|gopher)://\
<^tab><space><nl>\
..more non-URL chars..",\
"<a href=#0>#0</a>",\
REGEX);
```

A similar trick activates E-mail addresses that appear in the text.

Well-Mannered GIFs

I hate downloading bit maps I didn't ask for. BYTE's server has plenty of pictures to offer, but it won't shove images down your throat. The translator now suppresses illustrations, photos, and screen shots behind links that announce the size of each GIF (see the screen above).

System for Humans, which is an alternative to freeWAIS. O'Reilly's WebIndex derives from version 1.0 of EIT's SWISH. I downloaded SWISH 1.1 from ftp://ftp.eit.com, compiled it on our BSDI 2.0 machine, and tried it. SWISH is tuned for HTML—e.g., it can index just fields tagged as titles or comments. It can also segment a large indexing job into many small ones, then merge the segments.

Since low memory was the likely cause of disk thrashing, I thought I'd try the merge option described in the SWISH *1.1* docs. No luck. WebIndex is a pure GUI tool that doesn't expose that feature.

O'Reilly put me in touch with EIT's director of Web publishing, Jay Weber. I `ftp`'d the archive to EIT, where Weber successfully indexed it with WebIndex on several test systems. EIT also added a progress meter to WebIndex that revealed speedy progress through 10 of 14 BYTE issues, then suddenly—molasses. Weber sent me a new, memory-optimized update (available at http://website.ora.com or ftp://ftp.eit.com/pub/website). It did work with my data.

The Folio Alternative

Folio's Infobase Web Server is a completely different way to serve an indexed collection to the Web. It's an EMWAC-based Web server mated to the Folio Views search engine. That means it does everything that normal Web servers do, and it can also convert existing Views infobases to HTML on the fly. If you have infobases on hand, this is just the ticket. Even if you don't, this approach has a lot going for it. Views has a lightning-fast indexer, handles huge data sets, deals with hierarchical documents, and does phrase and proximity searches.

If you're a Views user, you can judge for yourself how well this Web converter reproduces Folio's Windows user interface. And while a series of retrieved Web pages clearly can't be as richly interactive or as responsive as a native application, this technique does inject client/server capability into Folio Views.

Visitors to the BYTE Web site have been trying all three search mechanisms. Folio and WebIndex are more popular than the less-capable freeWAIS, but freeWAIS is faster for single-term queries. Because effective use of the Web requires searching, I'll continue to explore these types of tools. ■

Jon Udell (judell@bix.com) is BYTE's executive editor for new media.

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Circle 96 on Inquiry Card (RESELLERS: 97).

Gateways to the Internet

America Online, CompuServe, and Prodigy offer Web browsers, FTP, and more, but these services aren't for everyone

GEORGE BOND

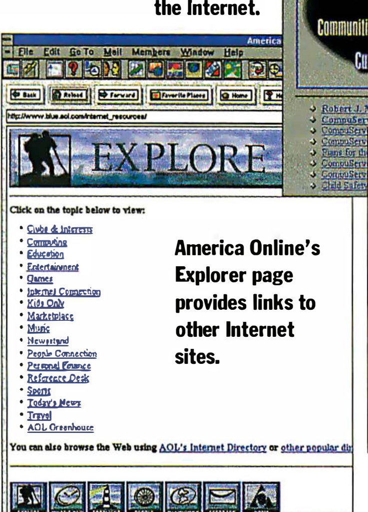
Access to the World Wide Web may seem an obvious component of any major on-line service, but the Big Three—America Online (or AOL), CompuServe, and Prodigy—are just now scrambling aboard the bandwagon. *All* three offer something you don't get from an ISP (Internet service provider): a single point of access for Web surfing, commercial database browsing, and on-line conference discussions. They also deliver single-source access to technical support and training.

The ISP Advantage

All these service providers—with the possible exception of Prodigy—tend to be more expensive than ISPs (see the text box "Convenience, but at What Price?" below). And the speed of phone connections to the Big Three is still mostly limited to 14.4 Kbps, a drawback when working with the on-line graphics of the Web.

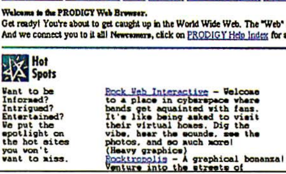
Also, the three providers promise to upgrade their networks, but at the time of this writing only a few 28.8-Kbps connections were available. In contrast, many ISPs offer 28.8 Kbps routinely. But these shortcomings may be offset by the large number of POPs (points of presence, or local phone numbers) offered by the Big Three, as well as by the convenience of one-stop access to services and support.

Prodigy is the only major information provider currently with an actual Web service. At this writing, CompuServe and AOL were still in beta testing with their Web browsers (graphical front ends for navigating the Internet and viewing Web pages) and Web services. However, users of these providers' services can walk the Web now by downloading the necessary software. Internet mail, FTP (the Internet's file transfer protocol), and Usenet news groups are already in place.



CompuServe's What's New page links users to popular new sites on the Internet.

America Online's Explorer page provides links to other Internet sites.



Prodigy's Welcome screen is the first thing you see when you jump to the World Wide Web.

Web-Crawling with CompuServe

CompuServe uses the Spry Mosaic browser, TCP/IP stack, and dialer (the company purchased Spry to obtain the technology, as AOL did with InternetWorks and its browser). There are so many free sign-up deals floating around that this initial expense will be nil, or close to it.

Once you're logged on to CompuServe, you use the command go ppp to get to the browser-downloading area. Then you either walk through menus to download the Windows version of the software or read instructions on how to connect via third-party Macintosh and OS/2 software. If you are using CompuServe's WinCim or

Convenience, but at What Price?

Using the Big Three commercial information providers can be expensive. Here's what it would cost to surf the Internet for 30 hours per month with each of them.

AOL (America Online). The first 5 hours are included in the $9.95 monthly fee. You're then charged $2.95 for each of the remaining 25 hours. Total: $83.70.

CompuServe. An initial charge of $9.95 includes unlimited use of basic services and 3 hours of Internet services (i.e., World Wide Web, FTP, telnet, and the Usenet news reader). An additional charge of $15 gets you an Internet Club membership with 17 more hours of connect time; each of the remaining 10 hours costs $1.95. Total: $44.90.

Prodigy. You get 30 hours of connect time under the 30/30 Plan. Total: $29.95.

To be fair, these comparisons aren't strictly parallel; CompuServe also has a mail surcharge (10 cents for the first 7500 words and 2 cents for each additional 7500 words per message) if you exceed approximately 90 three-page, full-text messages a month. But time spent in mail is not counted toward connect charges. The other services don't have a mail surcharge; they account for mail in their regular connect-time charges.

By comparison, ISPs (Internet service providers), companies that offer gateways to the Internet but rarely any local databases, have charges ranging from about $20 to $30 for 20 to 40 hours of access via 28.8-Kbps or slower modems, plus a dollar or two per hour for additional time.

TECHNOLOGY FOCUS

Turning an Ugly Duckling into a Hollywood Swan

To seamlessly integrate the World Wide Web into its existing service, CompuServe faced two technical challenges: supporting the Internet protocols and getting the software front ends (i.e., the CompuServe access software and the Web browser) to talk to each other. Last spring, CompuServe delivered a downloadable Web browser, called NetLauncher, that could work from within a PPP (i.e., standard Internet) session established by the dialer built into the WinCim 1.4 interface. But if you'd already used WinCim to dial into CompuServe, you had to disconnect before dialing the PPP session.

The latest upgrade to CompuServe's Windows shell, WinCim 2.0, lets you dial a single phone number and toggle between any Web browser and the CompuServe interface in the same session. The improved integration is principally due to the Windows Sockets, or Winsock, DLL. Winsock presents a network-independent interface between Winsock-compliant applications. This interface sits on top of a network-dependent component that supports the specific networking protocol stack (usually, TCP/IP).

For the new version of WinCim, CompuServe programmers wrote a Winsock networking layer for both NetLauncher and WinCim. Both the Web browser and the CompuServe front end now hook into the Winsock API. This result is point-and-click access to both NetLauncher (or any other Winsock-compliant Web browser) and CompuServe.

CompuServe has also met the challenge of different software commands by adding translation algorithms to the mix. NetLauncher and WinCim can now talk each other's lingo. For instance, when a user types `go politics` in NetLauncher, it recognizes the command as being intended for a CompuServe Go page and passes the command in a message to WinCim.

Where Winsock Fits In

Any Winsock-compliant application	Spry Mosaic CompuServe edition 2.0	WinCim 2.0
Winsock	Protocol stack (independent layer) Windows Sockets DLL Protocol stack (dependent layer)	
Protocol stack	TCP/IP dialer	
	Hardware drivers	
	Hardware (NIC, serial port and modem, etc.)	

Due out this month, WinCim 2.0 integrates formerly separate interfaces for accessing CompuServe and World Wide Web services using WinCim and NetLauncher, respectively. Both will also now be able to access the same live PPP connection established by CompuServe's dialing software and exchange commands intended for each other's domains.

Navigator software, you simply point and click to download the browser.

You run a single executable to install the software. If you already have a TCP/IP stack installed, CompuServe's stack will rename your stack and install its own. Your existing Internet client software probably will work with the new stack.

If you've seen Spry's Mosaic browser elsewhere (in the Internet-in-a-Box package, for example), you'll immediately recognize CompuServe's: It has the familiar menu bar and line-of-control buttons along the top of the screen, two long boxes in which you enter URLs (uniform resource locators, which are simply Internet addresses), and the familiar Spry globe for indicating when data is being transferred.

The browser defaults to the CompuServe home page on connection. You have three choices for navigating the Web: Clicking on one of the hot links on the screen, selecting a location from a hot list that you create, or typing in the URL of the site that you want to visit after you use the open URL command (by typing Ctrl-O or selecting Open URL… from the File menu).

The Spry stack and dialer are among the more robust that we've used, and CompuServe's version performed without a problem. During several weeks of use, our CompuServe setup behaved reliably on a Gateway P5-60 and an IBM ThinkPad 360C. The Spry browser also performed well, including properly handling home pages built with the Netscape extensions. Because these extensions aren't part of the current HTML (Hypertext Markup Language) standard, they can cause problems with the way in which some browsers display images.

The downside of CompuServe's Internet access is its lack of integration. To browse the Web, you must call a specific phone number and use the Spry software. To peruse news groups, or to use FTP to download a file or use telnet (a remote terminal program), you must resort to a terminal emulator or one of CompuServe's custom software packages. CompuServe is working to address these issues; see the Technology Focus box at left.

On Target with AOL

Like CompuServe, AOL was still beta-testing its Web software during our review period. However, unlike CompuServe's software, AOL's is nicely integrated into the regular AOL package, as are the clients for FTP, news groups, and gopher (a database search engine).

You will need special software to browse the Web from AOL. The current distribution disk is version 2.0. You must load this version of the software to get AOL in the first place. To use the Web browser, you need the version 2.5 preview edition, available for downloading from AOL.

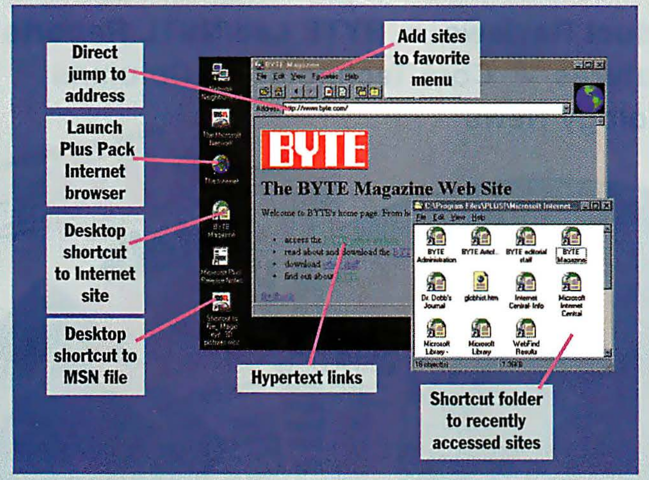
If you're working from a LAN that is linked to a T1 connection to the Internet, you'll find a pleasant surprise: One of the setup items in the network-selection pull-down menu is TCP/IP. It worked for us with no fuss on NetWare networks. We were able to connect virtually instantly and run AOL at T1 speeds. AOL is rapidly adding 28.8-Kbps connections for high-speed modem access, but so far they are concentrated in major metropolitan areas.

The browser itself looks a bit different from most of its competitors; it's much more boxy and industrial looking. The usual menu bar and collection of buttons span the top of the screen, but the buttons are long, horizontal rectangles instead of the more common squarish ones (see the screen on page 229).

Walking the Web with AOL is a breeze. You simply click on hot-linked icons or text links to jump to another page, or you type in a URL just as you would with any

MSN: Desktop Internet

With a vision of extending the Windows 95 desktop out to the world, Microsoft is busy building seamless World Wide Web access for the Microsoft Network, or MSN. Microsoft licensed the NCSA (National Center for Supercomputing Applications) Mosaic Web Browser from Spry International and, more significant, bought minority interest in UUNet, the world's largest ISP (Internet service provider).



Microsoft is now extending both, enhancing Mosaic to support the Windows desktop (e.g., drag and drop, right mouse-clicks, and so on) and branching UUNet into more sites worldwide. Currently, the Internet access points are limited—we had to call in to New York from New Hampshire—but Microsoft intends to open many additional lines shortly.

The enhanced browser, a component of the Microsoft Plus Windows 95 Companion Pack, accesses the Web through your own service provider, across the LAN (if you have a LAN-based connection), or via MSN. The Plus Pack sticks an Internet icon on the Windows 95 desktop.

You click on this icon to launch the browser, starting off in a Microsoft Web page that serves as an opening menu. From there, you can take a tutorial, go surfing on your own, or search for specific subjects using the Lycos Internet catalog. Once you're out of Microsoft's page, you're navigating the Web just as you would expect, jumping across various sites by clicking on hyperlinks or hopping directly to specific addresses.

From the menu bar, you can create a desktop shortcut to any site, build a list of favorite sites, or pull up a history window of recently accessed pages. You can drag and drop text or images to the desktop or to other applications. To capture an image to disk, you simply point at the image, click the right mouse button, and select Save As.

Where to Find

Microsoft Corp.
Redmond, WA
(206) 882-8080
fax: (206) 936-7329
www.microsoft.com

browser on a standard ISP. Using other Internet clients is just as easy. They are well integrated, also appearing as launchable icons. A news-group reader, a gopher/WAIS (Wide Area Information Service) client, and an FTP client are available.

Prodigy Plows Ahead

Prodigy, after a long, uphill battle against skepticism, has gained an edge on its competition. Its Internet access is easily the best integrated of the three services.

To be sure, most of Prodigy still looks like—well, Prodigy. Its screens have a decided look of NAPLPS (North American Presentation-Level Protocol Syntax), an older standard that features big characters, crude graphics, and generally an old-days-in-cyberspace appearance. However, its Web browser propels Prodigy into the mid-1990s. With its high-resolution display of non-Prodigy pages, it provides a sharp contrast to the rest of Prodigy.

The browser itself is efficiently laid out: It has the usual menu bar at the very top, and buttons and URL boxes under the bar, with an activity indicator next to them. There's no special installation needed for the browser because it's part of the normal Prodigy installation.

Prodigy's browser is easy and intuitive to use. Just click on what you want, and you're there. How fast you get there is limited by the connection speed of your modem—in Prodigy's case, it's 14.4 Kbps, although 10 major cities were expected to get 22.8 Kbps by late July. That's better than 9600 bps, but it can lead to slow transfer times when you're dealing with graphics-intensive home pages. The Prodigy home page itself is skillfully designed to load fast: It has a modest-size graphic at the top and then, like the CompuServe home page, drops into a heavily text-oriented page.

Do We Have a Winner?

For general prowling around the Internet, we'd select AOL because of its good integration and high-speed modem (and T1) connections. Prodigy would run a close second, falling somewhat short because of its slower modem links and lack of a T1 connection. CompuServe brings up the rear. Without the upcoming improvements in WinCim, it's simply too much work having to switch back and forth from the main system to the Web browser.

The wild card is Microsoft Network, or MSN, Microsoft's fledgling network (see the text box "MSN: Desktop Internet" above). Built with Internet integration in mind, it should compete as an Internet gateway right out of the starting block. ■

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fax: (614) 529-1610
sales@cis.compuserve.com
Circle 1034 on Inquiry Card.

Prodigy $9.95
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into99a@prodigy.com
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Presentation Quality

Snap-on, snap-off: IBM's slick new screen technology turns the ThinkPad 755CV into a remote-control color presentation panel

EDMUND X. DEJESUS

You've never seen anything like IBM's ThinkPad 755CV notebook computer—guaranteed. A superb blend of at least three interesting technologies, the base machine includes a 100-MHz 486DX4 processor (upgradable to a Pentium); a 10.4-inch, 65,536-color active-matrix display; a TrackPoint III pointer; and PC Card, or PCMCIA, slots for one Type III or two Type I or II cards. The ThinkPad 755CDV, a 755CV with an integrated CD-ROM drive, was released in June.

That's pretty good for starters. But in addition to all that, when you undo a latch on either side of the screen, the reinforced casing lifts off the back of the screen, transforming the now-transparent screen into a presentation panel that opens flat for simple attachment onto any standard overhead projector.

Thus, your presentation can be show-*and*-tell, with the integrated Mwave DSP (digital signal processor) chip delivering audio narration, music clips, and sound effects. This DSP chip also supports recording and playback, MIDI and Sound Blaster support, and a full-duplex speakerphone in conjunction with the internal 14.4-Kbps fax modem.

And, to enable you to magically control your presentation from across the room, front and rear infrared ports accept commands from the wireless MindPath Technologies infrared remote control. MindPath's Presentation F/X software lets you control mouse-cursor movements, click and double-click, and invoke any of over 20 special effects. The infrared ports also allow the exchange of data with IRDA-standard (Infrared Device Association) printers and other computers at rates as high as 115.2 Kbps.



LARRY DUNN © 1995

TECHNOLOGY FOCUS

Double Your Pleasure

Ted Selker got tired of hearing people say that it couldn't be done. So, to prove a point, the IBM research scientist performed surgery on the back of a ThinkPad that he bought at retail. That was the prototype of the 755CV's presentation panel.

Color active-matrix TFT (thin-film transistor) LCD screens are difficult enough. Between the protective surfaces are polarizing filters and one plane of liquid-crystal gel for each of three colors (red, green, and blue); each plane is coated with transistors that control each pixel. When a tiny transistor is turned on, the liquid crystal at that point twists, losing transparency.

In the 755CV's design, the LCD display is held in a rigid die-cast aluminum frame whose top holds a CCFT (cold cathode fluorescent tube) light source, a backing reflective Mylar foil, and the power supply for the light. When the back casing is in place, a switch in the display base activates the light source. This interlock prevents safety risks while the back is off.

The 755CV's screen opens flat (see the inset above). Special straps attached to the notebook fasten the entire machine onto an overhead projector, with the screen suspended about 2 inches above the projector's surface. This space dissipates the heat from the projector. The final result is a marvel of engineering—and a practical product to boot.

The Competition

There are other presentation panels that offer remote control; there are even other notebooks that can turn into presentation panels, including Aquiline's Cruiser, Boxlight's Multibook, IntelliView's DPS-1 and DPS-3, and Revered Technology's Power Cruiser. But there's nothing else that offers the flexibility and gee-whiz appeal of the 755CV. And, for approximately the same price that you would pay for the LCD color active-matrix projection panels that are currently on the market ($4000 to $12,000), you can purchase a projection panel *and* a full-featured ThinkPad in one box.

The Class B 755CV weighs 6.6 pounds with battery pack, and you can swap out the front-mounted 3½-inch floppy drive for another PC Card slot or a wireless modem. On BYTE's Thumper 2 battery-life test, the Energy Star–approved 755CV scored 3 hours, 38 minutes, which is in line with the claimed 3.3 to 10 hours (4.1 to 12 hours with the optional lithium-ion battery).

Two minor complaints are that the system has no handle, and setup for the infrared remote control is not intuitive. But if you're weary of making and carrying overhead foils—or if you just want to impress other technophiles—you'll find your machine in the 755CV. ■

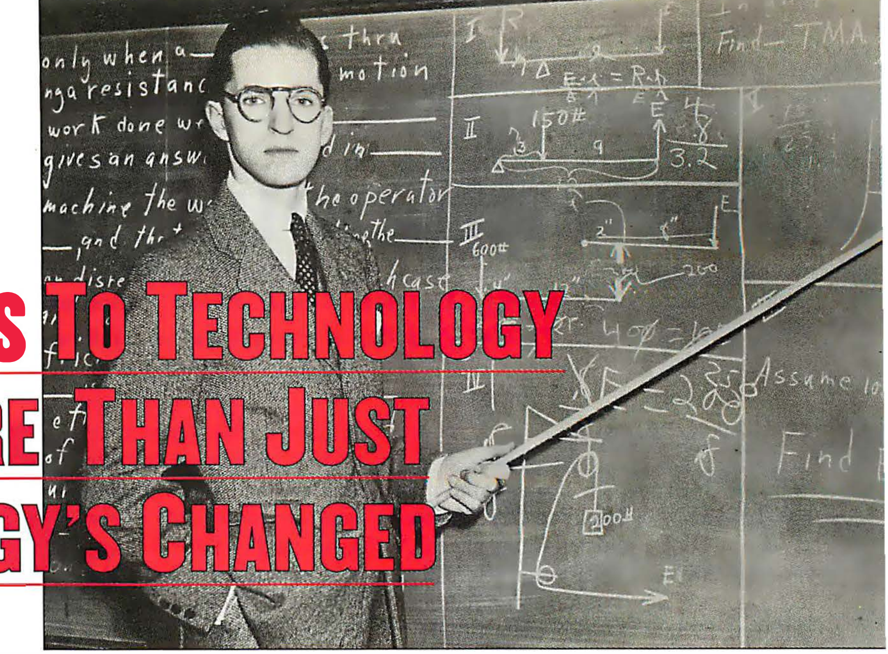
Edmund X. DeJesus is a BYTE senior editor. He has a Ph.D. in physics and has been a professional programmer for over 15 years. You can reach him on the Internet or BIX at edejesus@bix.com.

Product Information

ThinkPad 755CV $6099
ThinkPad 755CDV $7099
(includes integrated CD-ROM drive)

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Networking at Warp Speed

Easy LAN installation and peer services make IBM's OS/2 Warp Connect a serious network contender

BARRY NANCE

To stem the tide of Windows 95, IBM has sweetened the OS/2 pot. IBM reasons that if OS/2's technical strengths don't overwhelm you, the boatload of networking and application software in the Warp Connect upgrade will be more persuasive.

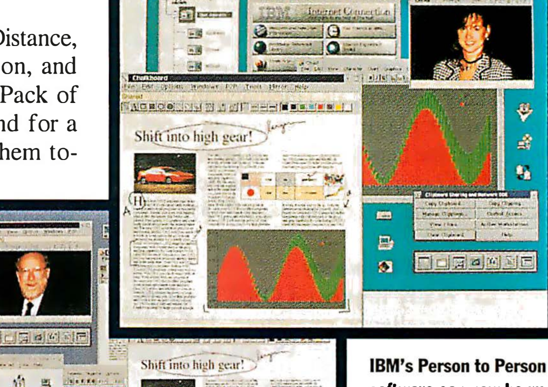
OS/2 Warp Connect bundles LAN requesters, peer-to-peer networking, groupware and E-mail, Internet access, a full-featured word processor, a spreadsheet, a personal information manager, a fax utility, remote access, communications programs, and other goodies. Curiously missing from Warp Connect is an NFS client for connecting to Unix servers; you have to buy NFS separately.

The new Warp is robust, reliable, and responsive. That's not surprising, since the underlying OS/2 technology has had years to mature.

Warp Connect ($299) costs significantly more than the $89 basic Warp product, and it requires roughly twice as much disk space and RAM.

Warp Connect takes from 25 to 90 MB of disk space and at least 12 MB of RAM, depending on which features you install. IBM recommends at least 8 MB, but we found performance is much better with 12 MB.

Almost all of Warp Connect's features, including the requesters, LAN Distance, CID (Configuration, Installation, and Distribution), and the Bonus Pack of applications, have been around for a while; Warp Connect brings them together in one box. However, the peer-to-peer networking is new, as is the installation program for network options.



IBM's Person to Person software can now be run with Warp's new Peer Services to provide peer-to-peer videoconferencing.

We installed Warp Connect on a dozen PCs (mostly 486s and Pentiums). The peer-to-peer networking services worked well and offered better security and reliability than Windows for Workgroups. The peer networking and LAN Server requester features let Warp Connect access files, printers, and CD-ROM drives on computers running Warp Connect itself; IBM's LAN Server and PC LAN Program; Microsoft's Windows for Workgroups, Windows NT, and LAN Manager; and Artisoft's LANtastic. Warp Connect peers and LAN Server clients can even use the same modems via shared serial port access to PCs running OS/2-based communications software. These Peer Services are, in fact, a superset of the LAN Requester in all ways except one: To run the LAN Server graphical administration tools, you must use the LAN Requester instead of Peer Services.

When we added the NetWare Requester, the resulting dual-protocol stack consumed extra extended memory, but it still left nearly 640 KB of conventional memory for each DOS and Windows session. Trying to use multiple protocols in a DOS or a DOS-plus-Windows machine, however, left us with insufficient memory to run applications. The only problem the NetWare Requester exhibited was slow access to NetWare drives assigned through the Network folder. Drive mappings that were established through the NetWare Tools utility behaved normally.

For smaller networks (typically 10 or fewer PCs), or for a decentralized campus environment, Warp Connect's Peer Services are useful and productive. Beyond eight or 10 clients, you'll need a separate file server running a product such as NetWare or LAN Server.

The networking utilities in OS/2 Warp Connect include Network SignOn Coordinator, a help database, and LAN Distance Remote. Network SignOn holds logon names and passwords and sends them out to the various services. The help database lets you perform keyword searches for frequently asked questions, setup guides, and descriptions of known problems. LAN Distance Remote is a client for a LAN Distance Server that lets your PC

The Networking Difference

Warp Connect augments basic OS/2 Warp with IBM and third-party network client technologies such as NetWare Requester 2.11, LAN Server 4.0 Requester, OS/2 Peer to Peer, LAN Distance Remote 1.1, Lotus Notes Express (an entry-level Notes client), and support for TCP/IP, IPX, and NetBIOS/NetBEUI. There's also a comprehensive TCP/IP LAN and SLIP/PPP dial-up client that can replace the Bonus Pack's TCP/IP client. IBM TCP/IP version 3, which can maintain a dial-up Internet connection and a network card connection at the same time, includes FTP and Telnet server software. Curiously missing from Warp Connect is an NFS client for connecting to Unix servers; you have to buy NFS separately.

IBM says it will ship a Warp Connect Extend Pack later this year that will add features designed specifically to appeal to larger enterprises, such as Communications Manager/2 desktop-to-mainframe software and IBM's multiprotocol connectivity software, AnyNet/2. IBM also says it's collaborating with Novell to produce a 32-bit NetWare Requester for OS/2.

use a modem to access server files, just as if your modem were a LAN adapter.

Warp Connect's Peer Services also deliver auditing, logging, and an interface to REXX, the OS/2 scripting language. You can monitor access to shared peer resources and write REXX scripts to automate routine tasks. The Network Clipboard/DDE lets you cut and paste clipboard data across the LAN or—if you use NetBIOS over TCP/IP—across the Internet. Peer Services also includes an OS/2 program for playing chess across a network. And the Person to Person application lets you do workgroup and videoconferencing (see the screen on page 235).

The Installation Ceremony

IBM has really improved OS/2's much-criticized installation procedure. The system's tool for detecting LAN adapters (see "Sniffing Out LAN Hardware" at right) correctly identified most network cards we tested, failing only with the difficult-to-identify Eagle NE2000 card: An NE2000 adapter (or clone) doesn't offer software a clear-cut ROM address or I/O port signature for identification purposes. The installation program easily recognized (and configured Warp for) cards from such manufacturers as Thomas-Conrad, Madge, IBM, Intel, and SMC.

You are offered three ways to install Warp Connect: easy, tailored, and hands-off. The hands-off installation method (called CID) is appropriate for large organizations that want to seed Warp onto many LAN-connected PCs quickly and painlessly. CID is an IBM-designed, over-the-wire software distribution mechanism that creates a redirected installation environment.

To quickly install a CID-enabled product such as Warp Connect across a LAN, you modify a template script supplied with Warp Connect and run the LAN CID utility. A component called the Service Installable File System (SRVIFS) handles file redirection between the code server and the client workstation. We found the CID scripts easy to set up and run.

A server-based LAN CID REXX program identifies the products that you want to install. Individual product-response files contain the menu selections and choices of features that you otherwise would have to provide interactively. A SRVIFS configuration file sets up the code server. The bottom line is that you can install Warp Connect (or another CID-enabled product) on about 300 PCs in a single day.

Wrapping It Up

We can't go without faulting the single input message queue, which makes it possible for one badly behaved Presentation Manager application to prevent other applications from receiving event-queue messages. Also, Warp Connect needs an intelligent maintenance utility for CONFIG.SYS statements, especially since network software can increase the number of such statements to more than 100. The lack of an NFS client is a glaring omission. And the installation program gets confused if there's more than one LAN adapter in your PC (though you can fix such problems by editing the CONFIG.SYS, NET.CFG, and PROTOCOL.INI files by hand).

Overall, though, OS/2 Warp Connect has a lot to offer. The combination of in-the-box networking with a mature 32-bit operating system that runs Windows, Win32s, DOS, and OS/2 software makes this a productive, useful environment. Warp Connect offers all the essential features of both Windows 95 and Windows NT while adding features (such as the Bonus Pack and Notes Express) that the competition lacks. ■

Contributing editor Barry Nance has been a programmer for 25 years. He is the author of Using OS/2 Warp 3.0, Introduction to Networking, *and* Client/Server LAN Programming. *You can reach him via the Internet at barryn@bix.com.*

Product Information

OS/2 Warp Connect 3.0 . . .$299
(CD-ROM only; includes Windows)
IBM
Armonk, NY 10504
(800) 342-6672
(914) 765-1900
fax: (313) 225-4020
Circle 1144 on Inquiry Card.

TECHNOLOGY FOCUS

Sniffing Out LAN Hardware

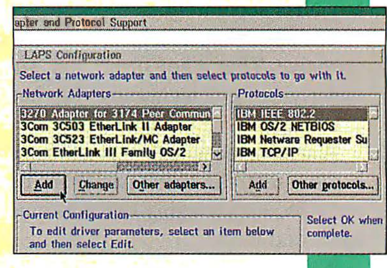
When you want to know what kind of LAN adapter your computer uses, you remove the cover and inspect the adapter. But installation software that wants to identify your LAN adapter has to use machine instructions to detect and identify such hardware. Micro Channel and EISA adapters are relatively easy to detect; both architectures supply configuration data to programs. ISA-based PCs, on the other hand, present installation software with a minefield of problems.

Warp Connect's installation program invokes functions within a DLL to sniff out LAN hardware. This DLL contains code that identifies 250 to 300 different network adapters; two-thirds of this code is for ISA adapters. IBM programmers regularly add new entries to the list. Each addition goes through regression tests to make sure the new code doesn't crash in the presence of the other listed adapters.

The DLL steps carefully through a series of adapter-signature tests to find out what LAN adapter you have. The tests first look through adapter ROM for patterns of bytes. Sometimes the software uses adapter-specific sequences of IN and OUT machine instructions to make the query. Because the same adapter can often use different I/O addresses and IRQs, the detection software often must make several attempts at identifying it.

The order of the tests is important. The same sequence of IN/OUT instructions that detects one kind of adapter might cause a different kind to freeze the computer. And the possibility of troublesome interactions between the detection software and adapters sensitive to certain machine instructions makes it important to figure out which adapters are examined first.

To run the detection code outside the installation procedure, open a Warp Connect OS/2 command-line session and run the OS2SNIFF program in the GRPWARE directory. OS2SNIFF will invoke the detection routines in NCD.DLL and display the results on-screen.



The installation program sniffs out network adapters, then gives you confirmation of those that are installed.

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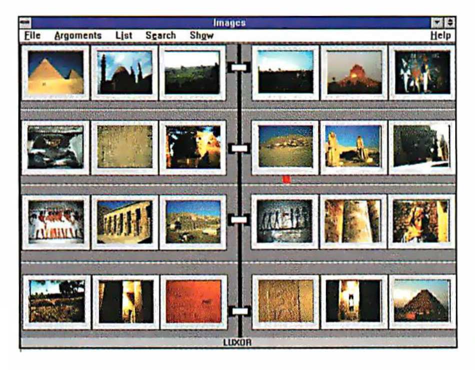
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It is also possible to active a "SLIDE" function which guides us on our personalized journey.



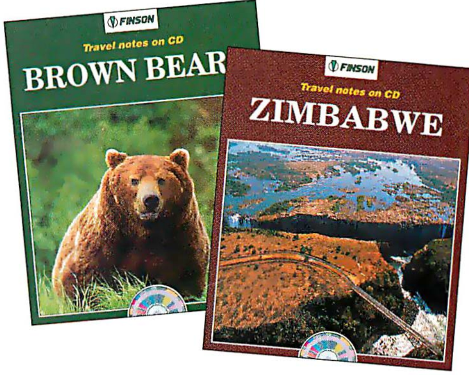
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Next-generation color lasers from Apple and Tektronix set high standards for print quality, connectivity, and convenience

TOM THOMPSON

The first generation of sub-$10,000 color lasers, introduced last year, suffered from complicated setup and lackluster out-of-the-box network capabilities. In short, they didn't work as advertised.

Enter Tektronix, the color printer kingpin, and Apple, creator of the desktop publishing market. Both companies know the color market well, and it shows in their latest color lasers: Apple's Color Laser 12/600 and Tektronix's Phaser 540. (The Phaser 540 Plus became available just after this review; it's a 540 with legal-size printing capability and a somewhat faster printing speed for the same $8995 price.)

Both of these printers readily manage true 600-dpi output; are easy to set up, thanks to a monocomponent print technology that dispenses with the developer cartridges; and are platform-agnostic, coming with drivers for Macintosh, PC, and Unix systems.



Sub-$10,000 color lasers: the Tektronix Phaser 540 (left) and the Apple Color Laser 12/600.

LARRY DUNN © 1995

Apple's Color Laser 12/600

Big and heavy, the Apple Color Laser 12/600 occupies a 21- by 23-inch area and weighs in at 110 pounds. A 25-MHz AMD 29030 RISC processor manages the printer's smarts, and 8 MB of ROM houses an Adobe PostScript Level 2 interpreter, 39 Type 1 fonts, and code that handles AppleTalk, NetWare IPX, and TCP/IP protocol stacks. Custom ASICs manage data compression and decompression and accelerate Apple's image-enhancement software.

Because the printer receives compressed image data, it needs less RAM than most color printers—only 12 MB (which comes in the base $6989 configuration). The board holds up to 40 MB of RAM in two industry-standard 72-pin SIMM sockets.

The controller board sports a medley of I/O ports: Ethernet (Apple AUI [attachment unit interface] connector), LocalTalk, and IEEE P1284 bidirectional parallel, plus an HDI-30 SCSI port for adding font-caching hard drives. The controller scans all ports for data and can field incoming jobs of different network protocols. The Canon HX LBP print engine generates up to 3 pages per minute for color output and up to 12 ppm for monochrome.

Phaser 540

With a 19.5- by 27.4-inch footprint and weighing 117 pounds, the Phaser 540 is also a bruiser. It uses an AMD 29030 controller (running at 32 MHz instead of 25 MHz). The ROMs provide Adobe PostScript Level 2 with 39 Type 1 fonts and include a PCL5 (Printer Control Language) interpreter. Standard RAM is 20 MB, expandable to 52 MB. A P1284 bidirectional parallel port and a SCSI-2 port are both standard.

You can attach the $1695 Phaser CopyStation option to add color-copying capability. An optional Phaser Share board ($595) provides either an Ethernet or a Token Ring network interface; both support AppleTalk, IPX, and TCP/IP (which is an extra $295). The controller switches between network protocols and emulations automatically. The Phaser 540's KME print engine can produce 3½ ppm for color and 14 ppm for monochrome at 600 dpi.

Product Information

Color Laser 12/600 . . $6989
Apple Computer, Inc.
Cupertino, CA
(800) 538-9696
(408) 996-1010
Circle 1030 on Inquiry Card.

Phaser 540 . . . . $8995
Tektronix, Inc.
Wilsonville, OR
(800) 835-6100
(503) 682-7377
Circle 1031 on Inquiry Card.

Blazing Colors

Setup for both printers is as easy as it gets: Basically, it takes around 15 minutes to insert the photoconductor drum/belt and the four toner cartridges. Overall, the Phaser 540 handled print jobs faster than the Color Laser 12/600 because of its faster processor. The overhead of data decompression may also slow down the Apple printer. The Color Laser 12/600 processed the BYTE color PostScript test (which measures the speed of the PostScript interpreter) in 129 seconds, while the Phaser 540 fielded it in just 59 seconds.

The Color Laser 12/600's operation was initially marred by its acute sensitivity to a bad cable on BYTE's network. The printer lost data packets and had them resent until it finally timed out. After we removed the faulty cable, the printer operated flawlessly. However, the Phaser 540, a Hewlett-Packard LaserJet IIID, and an Apple LaserWriter Pro 630—all located within several feet of the Color Laser 12/600 and connected to the same network—experienced no network difficulties from the bad wire.

continued

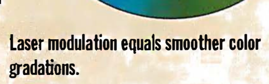
TECHNOLOGY FOCUS

Squeezing Colors from Pixels

Printing black text is fairly straightforward: Any given spot on the paper either has black pigment on it or does not. To get smoother edges or higher resolution, many laser printers adjust the size and even the position of the black dots on the image grid by modulating the laser beam.

Producing photographic images is more complicated because the printer must create the illusion of gray shades by tiling varied groups of black dots called *dithering patterns.* The gray shades come at the expense of resolution, but, again, laser modulation can help, either by making dithering patterns less obvious or by squeezing more gray shades from a smaller pattern. The production of dithering patterns is even more complicated with color images, because clusters of the four process colors (cyan, magenta, yellow, and black) must imitate various hues.

Both Tektronix and Apple have developed methods to effectively coerce more colors from smaller dithering patterns. By modifying the laser beam's pulse duration to give some pixels more or less energy than others, the printer's electronics affect how many ultrafine toner particles adhere to a each pixel. The result: several intensity levels for each color instead of all or none.



Laser modulation equals smoother color gradations.

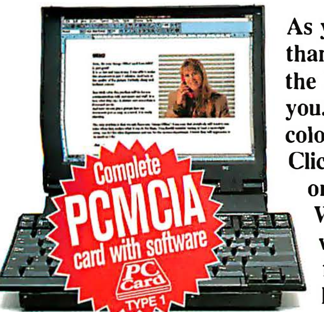
Apple is aware of the problem.

Both printers handled Mac and Windows print jobs without a hitch. Plain-paper output from these printers is simply outstanding, and output with photographic images is good enough to threaten sales of dye-sublimation printers. There is little overall quality difference between the two printers, although the Apple unit appeared to do better on more types of images than the Tektronix unit did.

If you're running lots of Windows applications that speak PCL5, consider the Phaser 540. If you're dealing with PostScript, either printer is suitable. While the Phaser 540 is substantially faster, it also carries a higher price tag. An Ethernet-equipped Phaser 540 with TCP/IP support costs $9885, while the Color Laser 12/600 comes with Ethernet standard (including TCP/IP support) for $6989. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from the University of Memphis. He is an Associate Apple Developer. You can contact him on AppleLink as "T.THOMPSON" or on the Internet or BIX at tom_thompson@bix.com.

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3-D Graphics Go Zoom

Intergraph and Omnicomp offer different routes to speedy 3-D

GREG LOVERIA

Most of us would love to navigate through complex virtual 3-D scenes on our desktop PCs. But functions such as real-time 3-D animation and Gouraud shading are tough jobs for even the swiftest CPU. Most desktop PCs have enough floating-point capability for the initial geometry calculations required by 3-D modeling, but you need specialized 3-D rendering hardware to quickly turn those internal geometric representations into realistic-looking images on the 2-D surface of your monitor.

The combination of lower-cost 3-D hardware and 3-D APIs—such as Silicon Graphics' OpenGL—is making that reality more affordable. OpenGL is particularly important because it's built into Windows NT and will eventually be part of Windows 95. Cards that support OpenGL will run lots of 3-D applications.

Here we evaluate two promising approaches to 3-D acceleration: a $2385 PCI card from Omnicomp that works with several currently popular 3-D APIs, including OpenGL; and a $23,850 Intel-based workstation from Intergraph.

Omnicomp's 3Demon cards are the first graphics adapters to use 3DLabs' new Glint 3-D accelerator, which promises good 3-D performance at a low price. (Glint-based cards from Elsa, Fujitsu, and others should be available by now.)

Intergraph's new TDZ-40 system belongs to a family that delivers workstation-level 3-D performance on the Intel x86 platform. The TDZ-40 also proves that a good 3-D chip is not enough in itself for great 3-D performance (see the text box "A Whole Lotta Buffers" on page 244).

The dual-Pentium TDZ-40 is a turnkey acceleration system for MicroStation, a CAD package from Intergraph subsidiary Bentley Systems. It uses Intergraph's two-card GLZ2, an OpenGL accelerator that works in conjunction with Intergraph's MOGLE (MicroStation OpenGL Extensions) 3-D API. Omnicomp's 3Demon adapters, while aimed at improving speeds of existing 3-D and CAD applications using various 3-D APIs, can also accelerate MicroStation performance speeds using MOGLE.

Intergraph's Pentium-powered TDZ-40 system combines workstation-level 3-D performance with Intel x86 software compatibility. The Omnicomp 3Demon SX48 board (perched atop the monitor) provides good 3-D performance for tighter budgets.

LARRY DUNN © 1995

3-D Demon

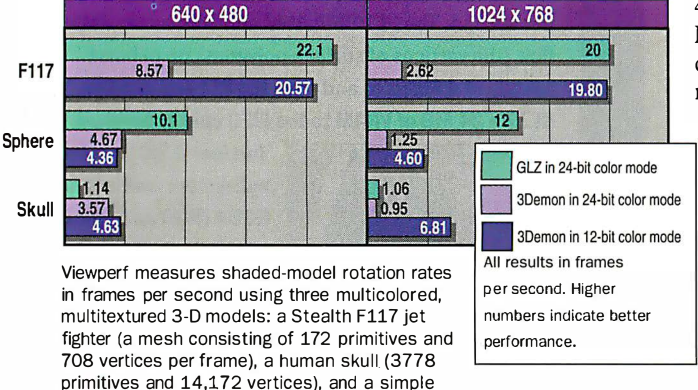
Omnicomp's 3Demon adapters all use the Glint 300SX 3-D graphics chip. Board models in the 3Demon series range from the $1995 SX44 (4 MB each of VRAM and DRAM) to the $3535 SX816 (8 MB of VRAM, 16 MB of DRAM). We tested a $2385 SX48, which has 4 MB of VRAM and 8 MB of DRAM. (Omnicomp plans an October release for its 3Demon TX series, which uses the new Glint 400TX processor to accelerate texture mapping.) The SX44 and SX48 use the 64-bit IBM525 RAMDAC for color conversions, while the SX816 has a wider 128-bit IBM528 RAMDAC. The three-quarter-size 3Demon cards use DRAM for 32-bit Z-buffering.

Jumperless and self-configuring, the SX48 installs easily alongside any existing VGA card, which is required for boot-up purposes. The SX48 supports display resolutions of 640 by 480 pixels with 24-bit color up to 1280 by 1024 pixels with 8-bit color. It also supports 24-bit-color, double-buffered, 3-D model acceleration at display resolutions of 640 by 480 pixels up to 800 by 600 pixels.

GLZ Sizzler

Available only in its TDZ line of workstations, Intergraph's PCI-based GLZ series of OpenGL graphics accelerators supports 24-bit color depth *only.* The GLZ1 adapter, which has 12 MB of VRAM, supports resolutions as high as 1152 by 864 pixels. The two-slot GLZ2 tested here supports resolutions of up to 1600 by 1280 pixels; it has 24 MB of onboard VRAM. Housed in an external cabinet, and packed with 34 MB of VRAM and 32 MB of DRAM, the truly scary GLZ6 supports real-time, fully texture-mapped, photo-realistic model walk-throughs. Other 3-D accelerators in this series include the GLZ3 through GLZ6. All GLZ boards are fully

Viewperf OpenGL Results



Viewperf measures shaded-model rotation rates in frames per second using three multicolored, multitextured 3-D models: a Stealth F117 jet fighter (a mesh consisting of 172 primitives and 708 vertices per frame), a human skull (3778 primitives and 14,172 vertices), and a simple sphere (2448 primitives and 9792 vertices). A single Viewperf frame consists of the model moving or rotating from one rendered *x,y,z* axes position to the next interpolated, rendered position in a 360-degree rotation about any axis.

Product Information

TDZ-40 ....$23,850
(with two 100-MHz Pentiums, 64 MB of RAM, 2-GB hard drive, 21-inch monitor)
Intergraph Computer Systems
Huntsville, AL
(800) 763-0242
(205) 730-5441
http://www.intergraph.com
Circle 1150 on Inquiry Card.

3Demon SX48 ....$2385
(4 MB of VRAM, 8 MB of DRAM)
Omnicomp Graphics Corp.
Houston, TX
(713) 464-2990
fax: (713) 827-7540
omnicmp@phoenix.phoenix.com
http://phoenix.phoenix.net:80/~omnicmp
Circle 1151 on Inquiry Card.

compliant with OpenGL and MOGLE and have built-in VGA support.

Prices for TDZ workstations, all with GLZ 3-D acceleration, start at $9900 for a single-Pentium TDZ-30 system (less monitor) and climb to $136,800 for the six-Pentium TDZ-60DS with GLZ6 accelerator, a 3- by 2-GB RAID system, 256 MB of system RAM, and 27-inch InterVue display monitor. Our test system—a 100-MHz dual-Pentium TDZ-40, configured with the GLZ2 accelerator, 64 MB of RAM, 2-GB hard drive, and superb InterVue 21-inch monitor—costs $23,850. TDZ workstations ship with a quad-speed CD-ROM drive and a keyboard with built-in microphone and Altec Lansing speakers.

3-D Performance

Several factors affect 3-D graphics performance: the host CPU and system bus, operating system, 3-D API, and an application's ability to perform multithreaded and multiprocessing operations. As a PCI-based system, Intergraph's TDZ-40 made a good base for testing the 3Demon card; it eliminated many of these variables. We compared the 3Demon to the TDZ-40's own GLZ2 adapter, also a PCI card, under Windows NT Workstation 3.5, with both MOGLE- and OpenGL-based benchmarks.

We also compared the 3Demon with a Matrox Millennium card, both running in the same Micron 120-MHz Pentium system. Though the Millennium accelerates 3-D, it didn't yet have OpenGL drivers and thus represents a very fast 2-D graphics accelerator for comparison purposes.

To test OpenGL 3-D performance, we used the Viewperf benchmark, developed by the OpenGL Performance Characterization Committee. It gauges 3-D performance with lines, solids, shaded solids, and textures. We tested both cards at resolutions of 640 by 480 pixels and then 1024 by 768 pixels with 24-bit color. We also tested static model rendering with MOGLE using MicroStation v5.00.95 and two 3-D DGN files ("bearing cutaway" and "pool architectural" drawings). The MicroStation command functions tested on both adapters consisted of wire mesh, hidden line, filled hidden line, and constant and smooth shading renders.

To put the 3-D performance of these products in perspective, the 3Demon board in its 12-bit color mode ran the Viewperf tests three to four times faster than the Matrox Millennium in its 8-bit mode at both 640 by 480 pixels and 1024 by 768 pixels. With both cards using 24-bit color, the 3Demon was only one-third to two times faster at a resolution of 640 by 480. At 1024 by 768, the 3Demon's 4 MB of VRAM wasn't enough to double buffer, and the two cards produced almost identical Viewperf results. For rotating and animating shaded models at a resolution of 1024 by 768 (or higher) with 24-bit color, you should consider the 3Demon SX88 or SX816, which have more VRAM.

Just as the 3Demon beat the Millennium, the Intergraph GLZ2 beat the 3Demon with both boards running Viewperf in the TDZ-40—at least during most tests. In 12-bit color mode, the 3Demon speeded up and averaged roughly the same as the GLZ2 (always in 24-bit mode), but that's an unfair comparison.

The size and complexity of the MOGLE pool model made real-time Gouraud-shaded walk-throughs impossible on the SX48, though wireframe-mode pans and zooms were fluid. The GLZ2 was only 20 percent to 50 percent faster than the SX48 when first running the MOGLE tests. However, on second runs, with display-list caching in its spacious RAM, the GLZ2 ran an amazing three to ten times faster than the SX48 with the MOGLE pool model.

During model-rotation and walk-through tests, the GLZ2, like the SX48, showed motion lags in the more complex pool model when doing Gouraud-shaded pans and zooms. But in wireframe and flat shaded modes, motion was fluid. Rotations of the MOGLE bearing-cutaway model at both resolutions and using Gouraud shading were less jerky with the GLZ2 than with the SX48. With the GLZ2, rotations were as smooth as glass in wireframe and flat shaded modes.

Though a bit pricey, an Intergraph TDZ workstation with GLZ acceleration technology is the top professional 3-D solution if you want the software compatibility provided by an Intel-based system. For budget-conscious people running existing 3-D applications on a PCI-based system, Omnicomp's 3Demon add-in boards are an excellent low-cost solution. ■

Greg Loveria writes and consults on animation and 3-D graphics from Binghamton, New York. You can reach him on the Internet at gloveria@spectra.net or loveria@bix.com.

TECHNOLOGY FOCUS

A Whole Lotta Buffers

While a single smart processor like the Glint 300SX can speed up 3-D rendering substantially, there's no substitute for lots of buffer space. Like other Intergraph GLZ adapters, the 24-MB GLZ2 employs a 220-bit-wide memory bus to service 92 video planes consisting of two 24-bit RGB buffers (double buffering for smooth animation) and one 24-bit Z-buffer that caches depth information. Masking, overlay, and image window–control bits account for the remaining 20 video planes.

The GLZ2 uses four custom proprietary Intergraph ASIC subsystems for 2-D and 3-D graphics acceleration. The DMA Engine is the main graphics acceleration processor; according to Intergraph, it touts 3-D speeds of up to 450,000 Gouraud-shaded triangles per second. The PCI/DMA ASIC controls vertex data flow (the vertices of surface polygons) up to burst speeds of 4 MBps to and from the PCI bus and the GLZ2's 24 MB of VRAM to the FIFO chip subsystem. The four-ASIC Resolver subsystem controls RGBA (RGB and Alpha channel) pixel and Z-data I/O to the frame buffer. A 256-bit-wide Analog Devices ADV7160 DAC handles color conversion.

Omnicomp's 3Demon SX48 provides substantial acceleration with OpenGL, but the TDZ-40's GLZ2 subsystem (pictured) is faster still. The SX48 keeps up only in its 12-bit color mode, which isn't a fair comparison.

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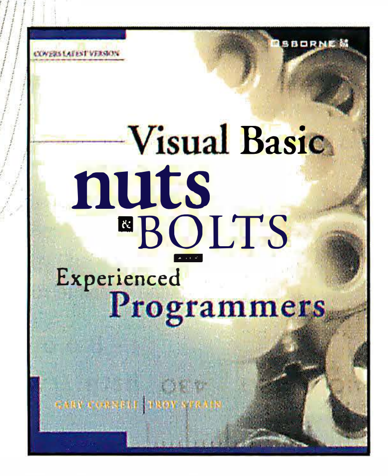
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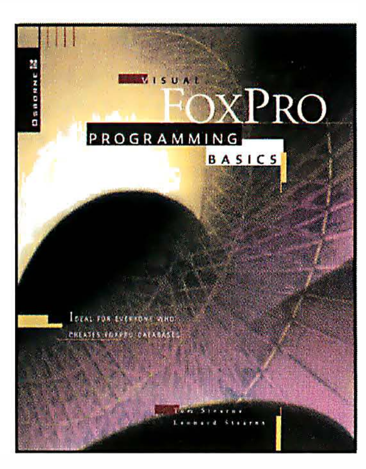
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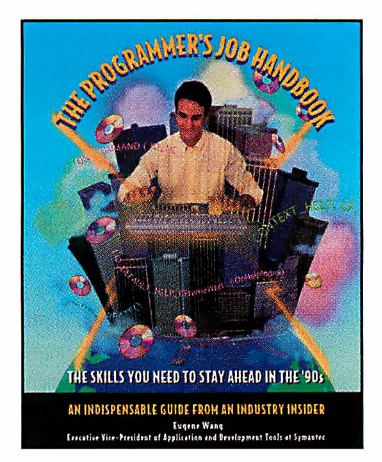




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FAX:716-827-5898

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Village Green Bookstore
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FAX:212-385-8193

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FAX:212-512-4105

Tower Books
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FAX:212-228-5338

Rochester
Total Information, Inc.
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FAX:716-254-0153

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Bull's Head Bookshop
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FAX:919-962-7392

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University of Cincinnati Bookstore
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Kent State University Bookstore
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FAX:610-265-6260
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16 Fast, Reliable RAID Subsystems

If network server downtime has you singing the blues, the disk array subsystems tested here will keep you and your organization up and running

MICHELE GUY

Your organization's network file server dies. Day-to-day operations are paralyzed. What do you do? This scenario occurs more and more frequently in today's office environments. However, the trends in computer use (e.g., centralizing data and applications on file servers and downsizing from mainframes to PC-size servers) mean that more companies are no longer tolerating server downtime—they want a solution. We tested 16 fast and reliable disk array subsystems that deliver multigigabyte storage and ensure that the data on your file server is always available. The price for this kind of insurance starts at about $10,000.

The disk arrays we tested employ a data storage technology called RAID (redundant array of independent disks). RAID addresses three key aspects of disk storage: (1) capacity, (2) speed, and (3) reliability. A disk array connects multiple smaller-capacity drives into a device that can appear to an OS as a large, single logical drive. The overall speed is better on these drives than on a large single drive because the heads on the smaller-capacity drives travel a shorter distance to perform read/write operations, and multiple drives support multiple simultaneous read/writes. RAID controller hardware provides data redundancy to improve reliability, either with a second mirrored copy of the original data or through various parity schemes; this allows a RAID array to continue to operate if one drive fails. (Unlike most other components in a computer, fixed drives contain moving

How to use this guide

We selected the best disk array subsystems by evaluating speed, features, and usability.

The Overall Score combines a product's weighted scores for performance (i.e., speed), features, and usability. Performance counted for half of the overall score; features and usability each was one-fourth of the overall score.

BEST OVERALL **Digital StorageWorks RAID Array 230 Subsystem**

BYTE September 1995 Best Disk Arrays

The Digital StorageWorks RAID Array 230 Subsystem was the clear winner in this category. Its fast performance and wide range of features, including redundant and hot-swappable drives, power supplies, fans, a sixth drive for a hot spare, and a write cache with battery backup, placed it well above the other subsystems. Its Online Management Utility for Windows NT provides an exact and readable status during a drive failure and rebuild operation.

		PRICE	OVERALL EVALUATION SCORE	FEATURES	USABILITY	PERFORMANCE INDEX OVERALL	SINGLE-THREAD	MULTI-THREAD
BEST	DEC StorageWorks RAID Array 230	$12,183	7.97	▲▲▲▲	▲▲▲▲	7.61	7.77	7.45
RUNNER-UP	Mega Drive Enterprise E-8 PCI	$11,900	7.06	▲▲▲	▲▲▲▲	6.28	7.60	4.96
RUNNER-UP	Storage Solutions Raca-Ray CM2-	$13,595	7.05	▲▲	▲▲▲	7.17	6.08	8.26
RUNNER-UP	Conner CR12-RAID	$16,593	6.56	▲▲▲	▲▲▲	5.47	4.69	6.26
RUNNER-UP	Winchester Systems FlashDisk SCSI	$19,737	6.55	▲▲▲	▲▲	6.18	6.11	6.26

Usability was judged on the quality of documentation, ease of configuration, and the ease with which the array was able to recover from a single drive failure.

Relative speed on a scale of 1 to 10 in a single-thread and a multithread environment.

We evaluated the disk arrays on their features (e.g., warranty length and coverage), number of redundant and hot-swappable components, support for a hot spare drive, and alarm types.

Relative overall speed on a scale of 1 to 10.

A Pillar of Reliability



REDUNDANT POWER SUPPLIES
Self-contained units that supply power to the array. If one fails, the other will keep the array going.

REDUNDANT FANS
Self-contained units that cool the array. If one fails, the other will keep operating.

FRONT-PANEL DISPLAY AND KEYPAD
Depending on the manufacturer, a keypad with LEDs can give the current status of the array and let you configure the array and perform maintenance (e.g., a rebuild).

INTERFACE CONNECTION TO THE HOST
On most of the units, this is a SCSI-2 Fast/Wide 68-pin female connection on the back of the RAID enclosure.

DRIVES IN INDIVIDUAL DRIVE SHUTTLES
We tested arrays with five half-height (3½-inch form factor) SCSI drives of 2-GB capacity each. Arrays are designed to let you easily install and remove drives.

SCSI BACKPLANE
Each drive connects to this when installed in the RAID enclosure.

ENCLOSURE KEYLOCK
Depending on the design, the RAID cabinet keylock prevents entry either to just the drives or to the drives and other components (e.g., power supplies and fans).

INDIVIDUAL DRIVE KEYLOCKS
Some models prevent unintended drive removal with a keylock for each drive; typically, the keylock must be in the locked position for the drive to operate.

BEST OVERALL

Digital StorageWorks RAID Array 230 Subsystem

The Digital StorageWorks RAID Array 230 Subsystem has it all—superior speed and features at a reasonable price. Its sleek enclosure houses redundant and hot-swappable disks, power supplies and fans, and a battery-secured write cache. It also supports a hot spare drive.
PAGE 250

BEST FOR DATABASE SERVERS

Digital StorageWorks RAID Array 230 Subsystem

The StorageWorks RAID Array 230 Subsystem outperformed the competition in handling transactions typical in a database server environment.
PAGE 252

BEST FOR AUDIO/ VIDEO SERVERS

Digital StorageWorks RAID Array 230 Subsystem

When it came to our audio/video benchmarks, the StorageWorks RAID Array 230 Subsystem was only the third-fastest subsystem, but its features and usability put it over the top once again.
PAGE 256

parts that make them more susceptible to failure).

RAID was originally defined as having five different levels. Each level addresses the issue of data redundancy in a different way. RAID level 1, which mirrors data, and RAID 3 and 5, which store parity information (also known as ECCs, or error-correction codes), are the most commonly used RAID implementations (for more on RAID level definitions, see the text box "On the Levels" on page 259).

We configured the arrays in our test to use RAID 5, which gives you a reasonable trade-off between cost and performance. RAID 5 distributes data and ECCs across the entire array (see the text box "How Error Correction Works" on page 250). RAID 1 offers faster performance but at a higher per-megabyte price, because half of the total storage space is sacrificed to the mirrored data. On a typical five-drive RAID 5 array, parity information takes up only about 20 percent of total storage space. However, some performance is sacrificed because writes to disk must also include an additional operation to update parity information.

When RAID was first conceived at the University of California at Berkeley in 1987, the *I* in RAID stood for *inexpensive*. One of the original motivating forces for the RAID developers was to create the most storage for the lowest cost. They found it was cheaper to string several small-capacity drives together than it was to use a single, large expensive drive. Today, companies are more likely to use disk arrays for their redundancy features than to achieve cost savings. Large-capacity drives are no longer necessarily more expensive than an array made up of smaller-capacity drives. As the price-per-megabyte of disk storage continues to fall due to ever-cheaper drives, more users may find a RAID 1 mirrored drive configuration as economical as a RAID 3 or a RAID 5 solution. Another trend may make the focus on RAID levels less crucial. So-called adaptive RAID controllers that dynamically select the best RAID level, using whichever level is optimal for a given set of data, may soon be available.

BEST OVERALL

DISK ARRAYS

Each of the 16 disk arrays we tested, with a few minor exceptions, consisted of a case enclosing an array of five half-height 2-GB drives, an array controller board or comparable hardware, a power supply and fan, and a configuration utility and LCD panel that lets you select the RAID level and make other array configuration selections. Most products provided some additional level of hardware redundancy, such as a sixth drive to be used as a hot spare, a second power supply, fan, controller, or some combination of these. All these arrays were designed to survive a single-drive failure.



From left: Winchester Systems' FlashDisk, Mega Drive's Enterprise, Conner's CR12-RAID, Storage Solutions' Raca-Ray, and Digital's StorageWorks.

For RAID 5 testing, we connected each array to a file server running Microsoft Windows NT 3.5 and formatted the array as one large drive (the formatted capacity of these arrays averaged about 8 GB). We ran a series of automated low-level disk tests that were designed to simulate the real-world conditions found on a typical disk subsystem connected to a PC file server.

The Best Overall winner is Digital Equipment's StorageWorks RAID Array 230 Subsystem. The StorageWorks had the fastest performance and the widest range of features, including redundant and hot-swappable drives, power supplies, fans, a drive for a hot spare, and a write cache with battery backup. The three-channel controller is designed to install in a PCI-based file server and can support two additional enclosures for up to 90.3 GB of storage. The StorageWorks' Online Management Utility for NT does a good job of giving you an exact and readable status during a drive failure and rebuild operation. The StorageWorks is also one of the least-expensive units we tested.

The second- and third-ranked products from Mega Drive and Storage Solutions, respectively, had virtually identical overall scores. Of the two, the Storage Solutions' Raca-Ray CM2+ was faster and had the best multithread performance score of any array we tested. The Raca-Ray's speed comes in a not-so-glamorous package; its drives sit in open, trackless

HOW ERROR CORRECTION WORKS

RAID 5 uses a technique that (1) writes a block of data across several disks (i.e., striping), (2) calculates a code from this data and stores the code on another disk (i.e., parity), and (3) in the event of a single-disk failure, uses the data on the working drives and the calculated code to "interpolate" what the missing data should be (i.e., rebuilding). A RAID 5 array "rotates" data and parity among all the drives on the array, in contrast with RAID 3, which stores all calculated parity values on one particular drive. The following is a simplified explanation of how RAID 5 calculates ECCs (error-correction codes).

Say, for example, that you have a five-drive array on which you intend to store four values: The numbers 172, 106, 240, and 156. For the purpose of this example, the RAID controller stores the value 172 as the binary number 10101100 on disk 1 of the array, the value 106 as the binary number 01101010 on disk 2, and so on as shown in the table "Error Detection: Bit by Bit" at right. When our four values have been written to disks 1 through 4, the RAID controller examines the sum of each bit position. If the sum of the numbers of bit position *x* on disks 1 through 4 is an odd number, then the value of that bit position on disk 5 is assigned a 1; if the sum is an even number, the bit position on disk 5 is assigned a 0.

Now assume that disk 2 fails. The RAID controller can no longer *see* the value 0 at bit 7 on disk 2. However, the controller knows that its value can be only a 0 or a 1. And as disks 1, 3, 4, and 5 are still operating, the controller can perform the following calculation: 1 + ? + 1 + 1 = an odd number. Since 1 + (0) + 1 + 1 = an odd number (3), the missing value on disk 2 must be 0. The RAID controller then performs the same calculation for the remaining bit positions. In this way, data missing due to a drive failure is *rebuilt*.

ERROR DETECTION: BIT BY BIT

A RAID controller examines the sum of each bit position to assign an even or an odd number to disk 5. If a disk fails, it assigns a 0 or a 1 to the missing value and performs a simple calculation. It repeats this process across each bit position, rebuilding the data as it goes.

	CONTENTS ON DISK:	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Disk 1	172	1	0	1	0	1	1	0	0
Disk 2	106	0	1	1	0	1	0	1	0
Disk 3	240	1	1	1	1	0	0	0	0
Disk 4	156	1	0	1	1	1	1	0	0
Sum		odd	even	even	even	odd	even	odd	even
Disk 5 (parity)		1	0	0	0	1	0	1	0

bays, making them somewhat awkward to put in and pull out. The Raca-Ray does not support a spare drive, but it does have a user-friendly monitoring utility called Raca-Lert for Windows (see "Honorable Mentions" on page 259). You can also expand this product to a three-rank unit for a total of 15 drives.

The Enterprise E-8 PCI from Mega Drive Systems is an attractively priced unit with good performance, features, and usability. The Enterprise is designed to let you mix and match different types of storage media, including half- and full-height drives, half-height optical drives, and half-height DAT (digital audiotape) modules. (Mega Drive reports that a popular configuration with its customers is an array with two mirrored full-height 9-GB drives.) The Enterprise has a dual-channel Mylex PCI controller with an HRI (Hardware RAID Controller Interface), which reports fan and power-supply failures to the file server. Our one complaint was due to the flimsiness of the door on the Enterprise's drive bays. Because the door doubles as drive tracks when you push the drives into the enclosure, its design sometimes made it difficult for us to seat drives properly. According to a company representative, Mega Drive has already retooled to correct this glitch.



Placing fourth and fifth, with nearly identical overall scores, were the CR12-RAID by Conner Storage Systems and the FlashDisk SCSI by Winchester Systems. The CR12-RAID uses a dual-channel controller, supports redundant hot-swappable drives, power supplies, and fans, and can be configured with up to 12 drives. It also has graphical monitoring utilities for NT and NetWare and a five-year warranty on both its drives and subsystem.

BYTE BEST — DISK ARRAYS

In a class all its own...

BEST OVERALL — Digital StorageWorks RAID Array 230 Subsystem

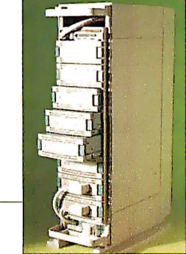


The Digital StorageWorks RAID Array 230 Subsystem was the clear winner in this category. Its fast performance and wide range of features, including redundant and hot-swappable drives, power supplies, fans, a sixth drive for a hot spare, and a write cache with battery backup, placed it well above the other subsystems. Its Online Management Utility for Windows NT provides an exact and readable status during a drive failure and rebuild operation.

			OVERALL EVALUATION			PERFORMANCE INDEX		
		PRICE	SCORE	FEATURES	USABILITY	OVERALL	SINGLE-THREAD	MULTI-THREAD
BEST	DEC StorageWorks RAID Array 230	$12,183	7.97	▲▲▲▲	▲▲▲▲	7.61	7.77	7.45
RUNNER-UP	Mega Drive Enterprise E-8 PCI	$11,900	7.06	▲▲▲	▲▲▲▲	6.28	7.60	4.96
RUNNER-UP	Storage Solutions Raca-Ray CM2+	$13,595	7.05	▲▲	▲▲▲	7.17	6.08	8.26
RUNNER-UP	Conner CR12-RAID	$16,593	6.56	▲▲▲	▲▲▲	5.47	4.69	6.26
RUNNER-UP	Winchester Systems FlashDisk SCSI	$19,737	6.55	▲▲▲	▲▲	6.18	6.11	6.26

Riding high on value

LOW-COST — Digital StorageWorks RAID Array 230 Subsystem



With its test-configuration price of $12,183, the Digital StorageWorks RAID Array 230 Subsystem is an excellent value. For this price, you get five drives and a sixth spare drive, a second power supply and fan, battery-protected write cache, monitoring utilities for Windows NT and NetWare, a one-year on-site warranty and a five-year warranty on the disk drives. Offering many of the same features is the $11,900 Mega Drive Enterprise E-8 PCI. The Enterprise has a standard two-year warranty and comes shipped with a DAT (digital audiotape) drive module in addition to its five-drive array and one spare drive.

			OVERALL EVALUATION			PERFORMANCE INDEX		
		PRICE	SCORE	FEATURES	USABILITY	OVERALL	SINGLE-THREAD	MULTI-THREAD
BEST	DEC StorageWorks RAID Array 230	$12,183	7.97	▲▲▲▲	▲▲▲▲	7.61	7.77	7.45
RUNNER-UP	Mega Drive Enterprise E-8 PCI	$11,900	7.06	▲▲▲	▲▲▲▲	6.28	7.60	4.96
RUNNER-UP	Procom LANForce-5	$10,255	5.97	▲▲▲	▲▲▲▲	3.91	4.67	3.15
RUNNER-UP	Raidtec FlexArray FX	$11,195	5.61	▲	▲▲▲▲	4.24	4.34	4.14
RUNNER-UP	DPT SmartRAID Subsystem	$12,615	4.94	▲▲	▲▲▲▲	2.08	2.59	1.57

KEY
Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

The Winchester FlashDisk SCSI offered better overall performance than the CR12-RAID but is priced considerably higher than the other top five subsystems. The FlashDisk is sold in configurations with up to 128 GB of storage capacity.

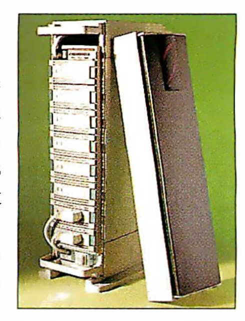
If you're on a budget, two of our previously mentioned winners—the Digital StorageWorks and the Mega Drive Enterprise—are priced at under $13,000. At $10,255, Procom Technology's LANForce-5 was the lowest-priced unit tested here. The LANForce-5 offers full redundancy and hot-swapping components---drives, power supplies, fans, and controllers, as well as a sixth drive for a hot spare—but its performance was below average. The company reports that a new high-performance controller will be available for this product this summer.

In analyzing the performance of these subsystems, it's apparent that RAID controllers play a major role. Three of the top-ranked arrays—Digital, Mega Drive, and Conner—use various models of controller from Mylex. It's interesting to note that write-caching didn't determine who made our top-five list. As neither the Raca-Ray nor the CR12-RAID had battery backups, their performance scores were based on their "write-cache off" results, and both still made the grade. As for reliability, participating vendors quoted the MTBF (mean time between failures) of the individual drives in these arrays as ranging from 500,000 to 1,000,000 hours. All the arrays we tested successfully withstood a simulated single-drive failure. Our tests did not measure the relative drop in performance that these arrays would experience while in rebuild mode (also known as degraded mode). On many arrays, when configuring the array, you can determine the rate of rebuild; the faster the rebuild, the more current server performance is slowed.

Best for Database Servers

Database servers are the computer workhorses of many organizations. Whether you're running an order-entry application in a manufacturing facility or trying to do inventory control for a supermarket, you need disk storage that's big, fast, and reliable.

We analyzed our benchmark scores to determine which of the 16 products tested perform best when connected to a database server. Our benchmark recorded the minimum, maximum, and average time it took to perform random and sequential reads and writes at various points in the array. Using the average times, we calculated scores that reflect how fast the disk arrays performed relative to one another. Our tests simulate two types of environments: single-thread and multithread, which approximate single- and multiuser workloads. When calculating scores, we gave more weight to sequential operations than to random ones to reflect the importance of such tasks as reading in a large data file or loading an executable file.


Digital StorageWorks RAID Array 230 Subsystem

Digital Equipment's StorageWorks RAID Array 230 Subsystem had the best overall performance and the best single-thread performance in this category. Storage Solutions' Raca-Ray and the Mega Drive Enterprise came in second and third, respectively. On nearly every multithread task, the Raca-Ray's score was the fastest. As in its overall score, the Enterprise handled single-thread tasks much better than multithread ones.

In fourth place was the Nordique Open Storage Facility by StorageTek Distributed Systems. The Nordique is sold as a stand-alone or as a component of the Nordique 9100, a modular RAID 5 system for users downsizing from a mainframe to a Unix or PC network. The Nordique was the slowest and most expensive subsystem of the top five, but its features and usability allowed it to edge out the faster Winchester FlaskDisk SCSI. Data is protected by redundant and hot-swappable drives, power supplies, fans, and controllers. The Nordique also offers battery backup and support for a hot spare.

SEPTEMBER 1995 BYTE BEST DATABASE SERVERS

DIGITAL STORAGEWORKS RAID ARRAY 230 SUBSYSTEM

The Digital StorageWorks RAID Array 230 Subsystem was fastest in tests that simulate a database environment. The StorageWorks' performance was the best of the arrays in our single-task tests and second-best in our multitasking tests. The Raca-Ray CM2+ from Storage Solutions was the fastest array at handling multiple processes, but it ranked fifth in single-task speed.

		OVERALL			PERFORMANCE INDEX		
	PRICE	EVALUATION SCORE	FEATURES	USABILITY	OVERALL	SINGLE-THREAD	MULTI-THREAD
DEC StorageWorks RAID Array 230	$12,183	8.62	▲▲▲▲	▲▲▲▲	8.91	8.76	9.06
Storage Solutions Raca-Ray CM2+	$13,595	7.36	▲▲	▲▲▲	7.78	5.91	9.66
Mega Drive Enterprise E-8 PCI	$11,900	7.34	▲▲▲	▲▲▲▲	6.83	8.41	5.26
StorageTek Nordique Open Storage Facility	$27,000	6.82	▲▲▲▲	▲▲▲▲	5.17	4.78	5.56
Winchester Systems FlashDisk SCSI	$19,737	6.81	▲▲▲	▲▲	6.72	6.64	6.79

Key: Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

FILE SERVERS WITH RAID

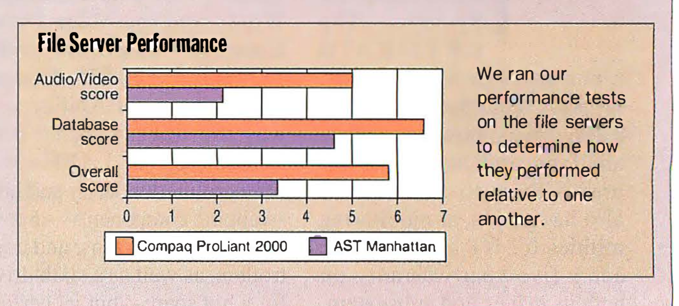
If you're in the market for a new file server and a disk array, you might consider a file server with a built-in array. We looked at two: the AST Manhattan P Series 5090 and the Compaq ProLiant 2000 M4200A.

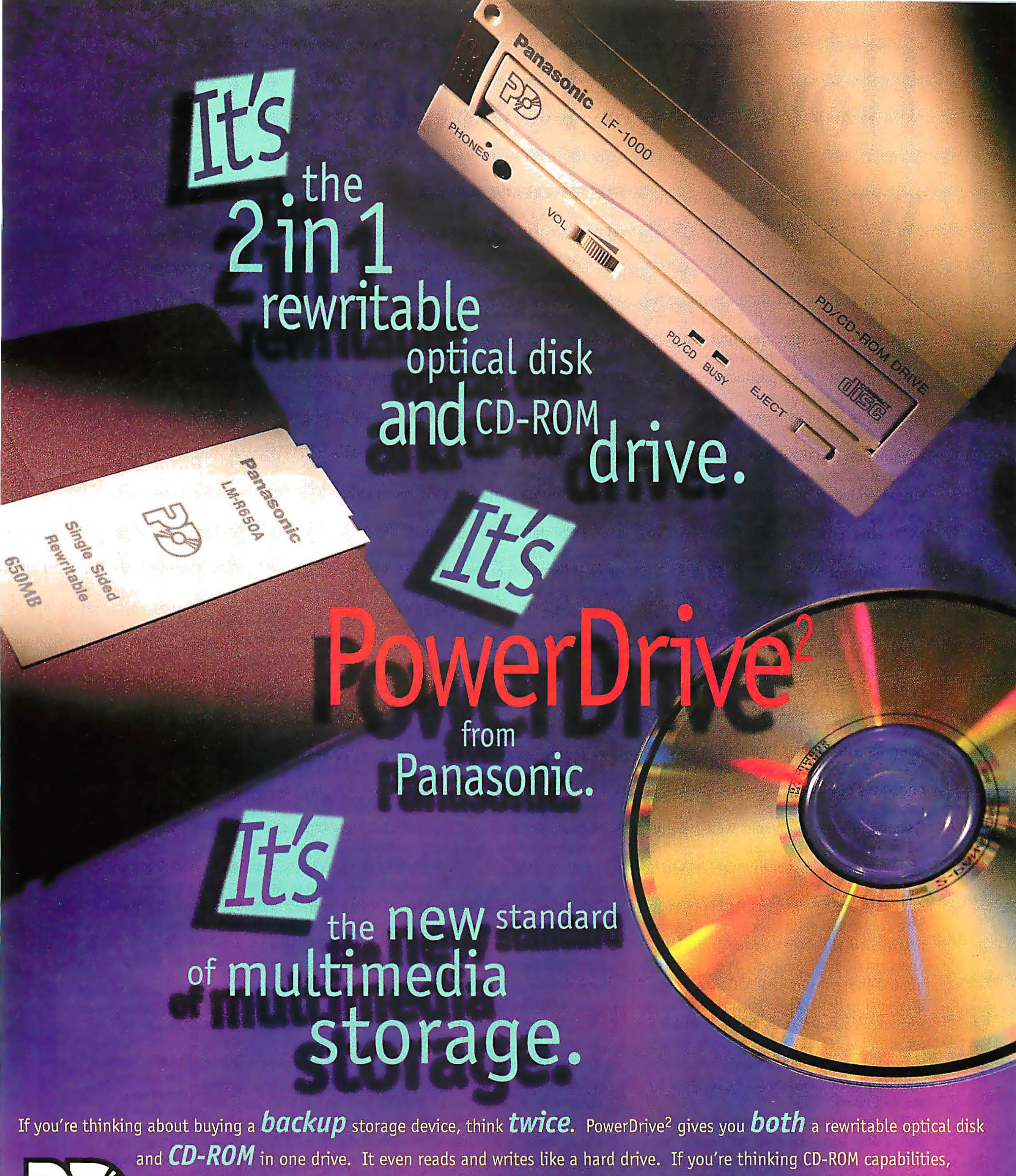
The AST Research ((714) 727-4141) Manhattan is a 90-MHz Pentium EISA/PCI (peripheral component interconnect) bus server that uses the DPT SmartRAID PM3224 PCI controller. The DPT controller has a graphical configuration utility called Storage Manager, which also handles event logging and user notification of error conditions. The AST Manhattan ships with Percepta, a server manager and monitoring utility for Windows NT or NetWare. The status of the disk array can be monitored from Percepta, which uses SNMP traps to hook DPT's Storage Manager. SmartRAID supports RAID 0, 1, and 5, a maximum cache of 64 MB, and hot swapping of drives. The AST Manhattan we tested was shipped with five 2-GB Quantum Empire Series 2100S hard drives and a CD-ROM drive. The price of the tested unit is $15,396.

The Compaq Computer ((713) 374-0484) ProLiant has dual Pentium 90-MHz CPUs and an EISA/PCI bus, and it uses the Compaq Smart SCSI Array Controller. Our test unit had five 2.1-GB Conner C2490A drives, which can be accessed from the server's front door, and a CD-ROM drive. The front door has an internal temperature monitor and a keylock for security. Drives are hot-pluggable, and the system supports seven half-height drives for a total of 14.7 GB. The array is configured via SmartStart, Compaq's CD-ROM-based configuration utility. The price of the unit we tested is $24,880 (the Compaq 1024 monitor is priced separately at $369).

We configured the disk system in each file server as a RAID 5 array of three 2-GB drives and installed Windows NT 3.5 on one of the remaining 2-GB drives as a boot drive. We ran our performance benchmarks on the file servers to determine how they performed relative to one another.

In the configuration tested, the Compaq ProLiant was consistently faster than the AST Manhattan. Had the ProLiant been tested with the subsystems, it would have ranked approximately sixth in overall performance and about fourth in database performance, but it was composed of three instead of five drives.





If you're thinking about buying a ***backup*** storage device, think ***twice***. PowerDrive² gives you ***both*** a rewritable optical disk and ***CD-ROM*** in one drive. It even reads and writes like a hard drive. If you're thinking CD-ROM capabilities, think 2X. And *4X*. PowerDrive² reads both existing *and* emerging titles. If you're thinking compatibility options, PowerDrive² gives you ***two*** of those as well. Its internal or external drive easily connects to any PC or Mac. PowerDrive² from Panasonic. **It will change the way you look at multimedia storage, forever.** For more information on the new Panasonic PowerDrive², call 1-800-742-8086, and ask for ext. PD.

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How We Tested

We invited each vendor to supply a disk array subsystem with five drives that have a total capacity of 10 to 12 GB, configured as a RAID 5 array. Although it wasn't required of them, some vendors also supplied a sixth drive to act as a hot spare. We specified that the subsystem's interface to the host be SCSI-2 Fast/Wide. Of the 16 products tested, 10 had RAID controllers built into their enclosures; eight of these products supported a SCSI-2 Fast/Wide single-ended termination and the other two supported differential termination. To connect the single-ended subsystems, we installed an Adaptec AHA-2940W PCI-to-Wide SCSI adapter in our test file server. To connect the differential products, we installed an NCR 8251D PCI SCSI adapter. The remaining six arrays shipped with their own RAID controller boards, which doubled as host adapters for these products.

We used a Dell PowerEdge SP590-2 system as our file server. The PowerEdge is a Pentium 90-MHz-based EISA server with two PCI (peripheral component interconnect) slots. Microsoft Windows NT 3.5 Workstation was installed on the boot drive of the Dell. We evaluated each product's performance, usability, and features, and the test results were weighted as follows: 50 percent, 25 percent, and 25 percent, respectively.

PERFORMANCE

We connected each disk array we were testing to the file server using the appropriate host adapter. We then formatted the array under NT as a single drive using the NTFS (NT File System) format. We ran a suite of performance tests under NT with the array's write-back cache off and then on (if both states were supported and could be toggled by the end user).

The performance suite simulates tasks that a disk array subsystem would perform in a real-world environment. Random and sequential reads and writes of 4-, 16-, and 64-KB blocks were performed at different locations on the array in a single-thread and a multithread environment. Except for the tests that read or wrote over the disk array, we set the number of blocks per segment so that the total size of the region under test was 128 MB.

PERFORMANCE SCORING

We recorded test results as the average, minimum, and maximum time (in seconds) required to complete each test. The average and maximum times gave performance scores; minimum times were for reference only. A product's score is relative to how it performed compared to the other products. Each product's Best for Database Servers score is a weighted average of the single-thread and multithread "average" recorded times. The Best for Audio/Video score is a weighted average of the single-thread and multithread "maximum" recorded times. The Best Overall score is an average of the database and audio/video scores. We used a product's "cache-on" times if the product was supplied with a battery-secured write cache; otherwise, we used the "cache-off" times.

FEATURES

We evaluated each product on its cost per MB of storage, warranty length and coverage, redundant and hot-swappable components, as well as alarms, security features, and maximum storage capacity.

USABILITY

We evaluated each product's ease of setup and configuration and the completeness and clarity of the user's manuals. We simulated a single-drive failure, verified that the file server could continue to operate normally, and evaluated the ease of performing a rebuild of the array.

Contributors

Michele Guy, Project Manager/NSTL, *has been testing hardware and software products for NSTL for the past four years.*

Kathleen Bishop, R&D/NSTL, *has eight years of R&D experience in the computer industry.*

Bruce Levy, Ph.D., Manager, R&D/NSTL.

The Lab Report is an ongoing collaborative project between BYTE magazine and National Software Testing Laboratories (NSTL). BYTE magazine and NSTL are both operating units of McGraw-Hill, Inc. Contact the NSTL staff on the Internet at editors@nstl.com or by phone at (610) 941-9600. Contact BYTE on the Internet or BIX at editors@bix.com or at (603) 924-2624.

RAID ADVISORY BOARD

The RAID Advisory Board is an organization dedicated to advancing the use and awareness of RAID and associated storage technologies. Started in 1992, RAB states its main goals as education, standardization, and certification.

As a forum for discussion on developments in the storage-technology industries, RAB recently sponsored RAID '95, a conference held in San Jose, California. During the four-day event, attendees could take a course on RAID basics, learn about the latest business and technical issues, and hear discussions about predicted future trends. Among the conference speakers was Garth Gibson, one of the three original researchers responsible for proposing RAID technology.

Joe Molina, chairman of RAB, reported that one of this year's hot topics was adaptive RAID, a technology in which there is no predefined RAID; instead, the RAID subsystem makes this decision for the user, based on patterns of data use. Another hot topic was integration—that is, RAID subsystems that incorporate other types of storage media, such as tape and CD-ROM, and that utilize hierarchical storage management (e.g., automatically migrating older data off a hard drive and onto a tape jukebox).

Molina predicted that by the year 2000, almost all systems will have RAID, except notebooks and low-end stand-alones. PCMCIA RAID will become a reality, as will support for interfaces other than SCSI, such as fiber channel and arbitrated loop. (Currently, about 90 percent of RAID products are SCSI-based.) Also by the year 2000, today's cost of about $2 per megabyte with RAID should decrease to about 25 cents per megabyte. Molina agreed that while vendors may find it difficult to make money in this kind of market, users will benefit, and there will be plenty of RAID products to choose from.



For more information on the RAID Advisory Board, contact:

Joe Molina, Chairman
RAID Advisory Board
13 Marie Lane
St. Peter, MN 56082
(507) 931-0967
fax: (507) 931-0976
0004706032@mcimail.com

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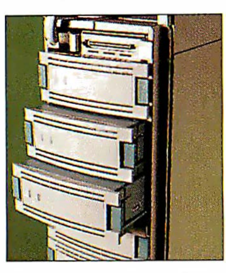
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Best for Audio/Video

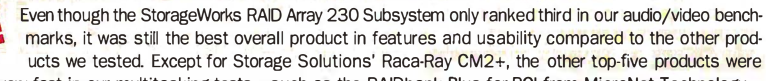
The sound and video files used in multimedia applications tend to be large, gobbling up disk storage and placing heavy demands on disk I/O. RAID subsystems can provide the disk capacity and performance required for these applications. To determine which RAID array would perform best in an audio/video environment, we looked at the maximum recorded times of each subsystem for each test in our performance benchmark. We used the maximum recorded times, because when looking for disk storage for audio/video applications, you want a system with the least amount of slow I/O. For example, a disk array that was relatively fast, on average, but had several slow results on read tests might, in a real-world environment, result in video clips that would run correctly and then "freeze" at certain points before resuming. The result would be similar to pressing the pause button on your VCR every 10 seconds or so while trying to watch a movie.



Digital StorageWorks RAID Array 230 Subsystem

Once again, the Digital StorageWorks Array placed first. Although it was only the third-fastest, the StorageWorks' features and usability made the difference. The speed demon of this group was MicroNet Technology's RAIDbank Plus for PCI. The RAIDbank, which uses a dual-channel Mylex controller, had the best performance overall and fast speeds in the multithread tests. The RAIDbank features redundant and hot-swappable drives, power supplies, and a hot spare. When configuring this subsystem, we took advantage of MicroNet's walk-through service, available to all new RAIDbank users (see "Honorable Mentions" on page 259). The RAIDbank's NT Adapter Monitor utility needs work; it did not issue an alert during our single-drive failure test. However, the Administration utility correctly detected the RAID's status as "critical," and an automatic rebuild took place as expected.

The Conner CR12-RAID and Mega Drive Systems' Enterprise E-8 PCI arrays were tied for third. The CR12-RAID performed multithread tasks faster than it did single-thread tasks, and the Enterprise handled single processes better. The Storage Solutions' Raca-Ray CM2+ was ranked fourth. It performed single-thread and multithread tasks at about the same speed.



SEPTEMBER 1995 BYTE BEST AUDIO/VIDEO

DIGITAL STORAGEWORKS RAID ARRAY 230 SUBSYSTEM

Even though the StorageWorks RAID Array 230 Subsystem only ranked third in our audio/video benchmarks, it was still the best overall product in features and usability compared to the other products we tested. Except for Storage Solutions' Raca-Ray CM2+, the other top-five products were either very fast in our multitasking tests—such as the RAIDbank Plus for PCI from MicroNet Technology—or fast in our single-task tests, but not both.

	PRICE	OVERALL EVALUATION SCORE	FEATURES	USABILITY	PERFORMANCE INDEX OVERALL	SINGLE-THREAD	MULTI-THREAD
DEC StorageWorks RAID Array 230	$12,183	7.32	▲▲▲▲	▲▲▲▲	6.31	6.78	5.85
MicroNet RAIDbank Plus for PCI	$16,395	6.85	▲▲	▲▲	7.22	5.14	9.30
Conner CR12-RAID	$16,593	6.79	▲▲▲	▲▲▲	5.95	4.12	7.79
Mega Drive Enterprise E-8 PCI	$11,900	6.79	▲▲▲	▲▲▲▲	5.72	6.79	4.66
Storage Solutions Raca-Ray CM2+	$13,595	6.74	▲▲	▲▲▲	6.55	6.25	6.85

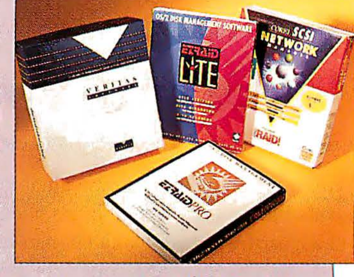
Key: Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

SOFTWARE RAID SOLUTIONS

Although the focus of our tests was hardware-based RAID (i.e., subsystems that use a dedicated RAID controller), if you've already invested in storage and don't have $10,000 or so to spend on a RAID subsystem, there are many software applications on the market that let you configure your existing disk storage as a RAID array. These software programs perform RAID calculations with the help of your server's CPU rather than relying on a dedicated RAID controller.

For a NetWare environment: **Corel ((613) 728-8200; fax (613) 728-9790) offers Corel SCSI Network Manager with CorelRAID 2.0 for $595. CorelRAID uses either RAID 4 or 5, can support a maximum of 16 drives, and supports the hot swapping of drives and a hot spare. Under NetWare, you can define users and groups to receive messages if a drive failure occurs. To use CorelRAID, you need a PC-compatible 386 server running NetWare 3.1x or higher, 4 MB of RAM, three SCSI hard drives, and a SCSI host adapter with ASPI (advanced SCSI programming interface).**

For an OS/2 environment: **Cyranex ((613) 738-3864; fax (613) 738-3871), formerly Pro Engineering, offers two software RAID packages for OS/2: EZRAID Pro for $795 or EZRAID Lite for $195. You can use EZRAID Pro with OS/2 version 2 or higher; it will work with SCSI, IDE, ESDI, and other types of hard drives and host adapters, although Cyranex recommends using SCSI devices. You can mix different drive types and host adapters within the same array. A minimum of two hard drives is required. EZRAID Pro supports RAID 0, 1, 4, or 5, supports hot sparing, and has a remote failure notification utility and performance monitor. EZRAID Lite is designed to be used with OS/2 desktop systems only and supports RAID 0 and 1. It also supports hot sparing and comes with a performance monitor utility.**



Software from Corel, Cyranex, and Veritas offers an inexpensive RAID alternative.

For a Unix environment: **Veritas Software ((415) 335-8000; fax (415) 335-8050) offers VxVM (Veritas Volume Manager) 2.0, which supports RAID 0, 1, and 5 with hot spare drives. VxVM 2.0 has a GUI for such on-line disk administration tasks as monitoring disk usage and fine-tuning to handle I/O bottlenecks. VxVM costs $1500 for desktop systems and starts at $3500 for desktop servers.**

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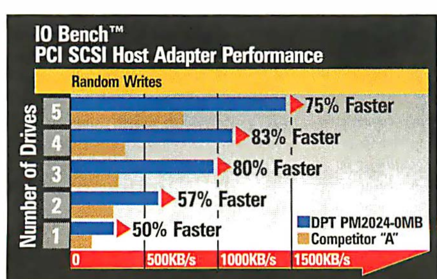
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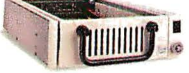
Our storage devices can endure long hours, natural disasters, and other forms of abuse.



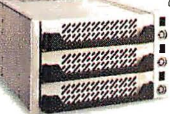




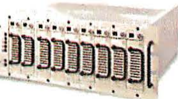
[Not unlike a day at the office.]



The DE100™ is a removable disk/tape subsystem that allows you to easily remove, transfer, and store data. It's compatible with an extensive variety of standard SCSI or IDE/EIDE drives.



With room for three 1" SCSI disk or tape drives, the DS300 model is the most compact removable storage subsystem available on the market today.



The DS500™ is an external rack mount that houses nine half-height bays, allows users to integrate any SCSI peripheral combination, and includes up to two 300-watt power supplies.



An ideal storage chassis for workstations, network servers, and PCs, the DS100 provides flexibility for users to mix and match up to four SCSI peripherals.





When it comes to protecting valuable data, only Kingston's rugged storage devices have shown they can brave the elements. Though they were designed to perform in the most demanding commercial environments, they're also tough enough to survive in army bunkers, submarines, and even in spacecraft. Our Data Silo® enclosures and Data Express™ removables are constructed of rugged steel with a carefully designed and tested ventilation system for cooling today's high-performance drives. Used in computer rooms, workstations, and network servers, they support more SCSI connections and have more options than any other storage subsystem on the market. If that doesn't impress you, our unbeatable five-year warranty will. So call Kingston or your nearest dealer for more information. Because in the world of storage systems, only the strong survive.

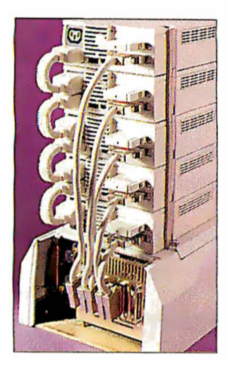


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HONORABLE MENTIONS

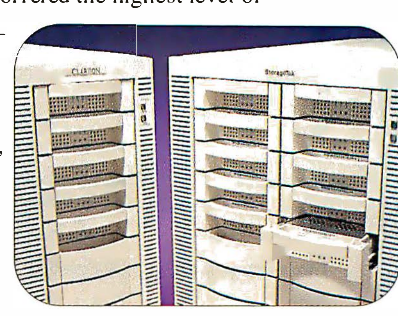


Artecon's line of Lynx products offers what it calls "100 Percent Investment Protection." You can start with a single-drive storage unit, move up to a stacked, multidisk configuration by interlocking individual storage units, and then graduate to a RAID tower by keeping the existing drive storage units and adding a RAID controller subsystem.

Raca-Lert for Windows is an optional monitoring utility for the Storage Solutions Raca-Ray CM2+. Its graphical design makes it easy to detect a drive failure and begin the reconstruction procedure. With a modem connected to the Raca-Ray's second serial port, Raca-Lert can dial an emergency number to a tone pager, or it can dial a fax machine if a fax modem is attached.

MicroNet Technology offers a unique service to all its new RAID customers: the name and number of a technician who will walk you through the installation of your subsystem. No fumbling around with a user's manual or searching for the technical-support number.

The Clariion C1300 and the StorageTek Nordique Open Storage Facility offered the highest level of protection against data loss—both include redundant drives, two power supplies, two fans, a second controller, and even a mirrored write-back cache. A copy of disk writes in cache is maintained on both controllers.



MORE ON THE RAID FRONT

We weren't able to test the following products, but they are worth mentioning:

Ciprico's 6900 Series of disk arrays are the first such products to use the UltraSCSI interface, which can transfer data at a maximum rate of 40 MBps. The 6900 Series was designed with film, video, and medical imaging applications in mind. The 6900 Series will be available in June. A nine-drive, 16-GB disk array costs $39,575.

To better compete with lower-priced, single-controller RAID subsystems, Clariion began shipping its C150 single-controller product in July. The C150 costs $10,995, which includes three 2-GB drives, 8 MB of cache memory, redundant power supplies and fans, and an interface kit for Sun, DEC Alpha, IBM, or Intel-based PC servers.

Hewlett-Packard is developing an adaptive RAID product called AutoRAID. The exact form AutoRAID will take is still under investigation. AutoRAID will dynamically adapt its algorithms to best suit the host system's data-use patterns. For example, newly written data that will probably have the most activity is stored using RAID 1 for better performance; as this data ages, it automatically migrates using RAID 5 for cost-effectiveness.

The Optima HST RAID Solution from Optima Technology is a RAID subsystem for NetWare and Unix applications. The Optima HST supports RAID 0, 1, and 5, up to 32 MB of cache, redundant hot-swappable drives and power supplies, a hot spare drive, and a SCSI-2 Fast/Wide host interface. It is available in configurations ranging from 6 to 115 GB. Prices start at $9995 for the 6-GB Optima HST 6000.

Xyratex, a former division of IBM located in the U.K., will begin shipping its R9000 subsystem in September. The Xyratex R9000 is a RAID subsystem for PC-compatible platforms running under a DOS, Windows, or NetWare environment. The enclosure has two integrated power supplies and fan units and supports up to seven drives. To expand it, you can add another tower for a total of 14 drives (56 GB). The R9000 supports RAID levels 0, 1, 3, and 5, and up to 64 MB of write cache. The R9000 is priced at £17,080.

Where to Find

Ciprico, Inc.
Plymouth, MN
(800) 727-4669
(612) 551-4000
fax: (612) 551-4002

Clariion
Westboro, MA
(508) 898-7600
fax: (508) 898-7501

Hewlett-Packard Co.
Santa Clara, CA
(800) 752-0900
fax: (800) 333-1917

Optima Technology Corp.
Irvine, CA
(714) 476-0515
fax: (714) 476-0613

Xyratex
Havant
Hampshire, U.K.
+44 1705 498851
fax: +44 1705 498853

ON THE LEVELS

RAID 0: Data is striped across drives; no data redundancy is provided.

RAID 1: Data redundancy is obtained by storing exact copies on mirrored pairs of drives.

RAID 2: Data is striped at the bit level; multiple error-correcting disks provide redundancy; not a commercially implemented RAID level.

RAID 3: Data is striped at the byte level, and one drive is set aside for parity information.

RAID 4: Data is striped in blocks, and one drive is set aside for parity information.

RAID 5: Data is striped in blocks, and parity information is rotated among all drives on the array.

HELPFUL HINTS

- Remember to back up regularly. The RAID 5 configurations used here won't protect you in the unlikely event of more than one drive failing.
- If you do invest in a RAID subsystem, you should go through a "dry run" of a single-drive failure before bringing the subsystem on-line. That way, you'll know ahead of time how to handle this situation. Make sure rebuild instructions and your vendor's technical-support numbers are posted near the array.
- Consider configuring your array with drives from several different manufacturers to reduce the risk of multiple drive failures. (One reason the drive makers quote overly optimistic MTBF [mean time between failure] rates in a RAID environment is that the drives in an array are likely to be from the same assembly-line batch; thus, when one drive fails, the others, being of the same age and manufacture, are likely to fail at or near the same time).
- The cable and terminator pins in the SCSI-2 Fast/Wide interface bend easily. Take care when connecting and disconnecting these devices.
- Finally, don't forget to have a spare drive on hand.

ROLL CALL OF DISK ARRAYS TESTED

FEATURES

MANUFACTURER	MODEL	PRICE AS TESTED [1]	PERFORMANCE: SINGLE-THREAD RELATIVE AVERAGE/MAX. PERFORMANCE [3]	PERFORMANCE: MULTITHREAD RELATIVE AVERAGE/MAX. PERFORMANCE [3]	HOST ADAPTER AS TESTED	HARD DRIVE	MAX. NUMBER OF DRIVES
Artecon, Inc.	LynxTower LX-5000T RAID Subsystem	$22,995	4.41/5.33	5.74/6.45	Adaptec AHA-2940W	Conner CFP2107S	7
Clariion Advanced Storage	C1300 Mirrored Cache Disk Array	$35,391	4.45/4.02	4.58/.66	NCR 8251D	Seagate Barracuda 32550N	10
Conner Storage Systems	CR12-RAID	$16,593 [2]	5.27/4.12	4.73/7.79	Mylex DAC960P2 dual-channel	Conner CFP2107	12
Data Storage Marketing, Inc.	HSRAID-8	$22,430	4.12/5.03	4.54/4.15	Adaptec AHA-2940W	Seagate Barracuda 32550N	7
Digital Equipment Corp.	StorageWorks RAID Array 230 Subsystem	$12,183 [2]	8.76/6.78	9.06/5.85	Mylex Backplane RAID Controller with Digital firmware	StorageWorks 2.1-GB Wide SWXD3-WB	7
DPT, Inc.	SmartRAID Subsystem	$12,615	3.96/1.23	2.51/.63	DPT PM3224/W	Seagate ST12400N	6
Legacy Storage Systems, Inc.	SmartArray XE	$20,957 [2]	5.31/4.92	4.47/6.90	Mylex DAC960P 3-channel with AEMI	Seagate Barracuda 32550W	12
Mega Drive Systems, Inc.	Enterprise E-8 PCI	$11,900 [2]	8.41/6.79	5.26/4.66	Mylex DAC960PD dual-channel	Seagate ST12450W	14
MicroNet Technology, Inc.	RAIDbank Plus for PCI RBT2PCI/RPC	$16,395 [2]	4.97/5.14	4.82/9.30	Mylex DAC960P2 dual-channel	Conner CFP2107E	6
Micropolis Corp.	RAIDION LTX 6.3 plus LM2100 Add-On Module	$15,000	5.93/2.39	2.74/2.01	Adaptec AHA-2940W	Micropolis Model4221	28
Perisol Technology	RaidSafe Plus 7 8MP	$13,864	4.68/4.87	5.38/4.07	Adaptec AHA-2940W	Quantum XP32150AL-S	7
Procom Technology, Inc.	LANForce-5	$10,255 [2]	3.88/5.46	3.85/2.44	Adaptec AHA-2940W	Seagate Barracuda 32550N	7
Raidtec Corp.	FlexArray FX	$11,195	4.23/4.46	2.56/5.72	Adaptec AHA-2940W	Quantum XP32150	5
Storage Solutions, Inc.	Raca-Ray CM2+	$13,595	5.91/6.25	9.66/6.85	Adaptec AHA-2940W	Seagate ST32550N	15
StorageTek Distributed Systems Division	Nordique Open Storage Facility	$27,000	4.78/4.55	5.56/.48	NCR8251D	Seagate Barracuda ST12550N	20
Winchester Systems, Inc.	FlashDisk SCSI	$19,737	6.64/5.57	6.79/5.74	Adaptec AHA-2940W	Seagate Barracuda 32550	8

FEATURES CONTINUED

MANUFACTURER	MODEL	RECHARGEABLE BATTERY BACKUP	TYPES OF SECURITY	PLATFORMS SUPPORTED: PC COMPATIBLE	PLATFORMS SUPPORTED: MAC	PLATFORMS SUPPORTED: POWERPC	OSES SUPPORTED: DOS	OSES SUPPORTED: WINDOWS 95	OSES SUPPORTED: WINDOWS NT
Artecon, Inc.	LynxTower LX-5000T RAID Subsystem	○	D	●	●	●	●	●	●
Clariion Advanced Storage	C1300 Mirrored Cache Disk Array	●	N	●	○	○	●	●	●
Conner Storage Systems	CR12-RAID	○	E	●	○	○	●	○	●
Data Storage Marketing, Inc.	HSRAID-8	Optional	N	●	●	●	●	●	●
Digital Equipment Corp.	StorageWorks RAID Array 230 Subsystem	●	E	●	○	○	●	○	●
DPT, Inc.	SmartRAID Subsystem	○	E	●	●	●	●	●	●
Legacy Storage Systems, Inc.	SmartArray XE	Optional	E	●	●	●	●	●	●
Mega Drive Systems, Inc.	Enterprise E-8 PCI	●	E	●	●	●	●	●	●
MicroNet Technology, Inc.	RAIDbank Plus for PCI RBT2PCI/RPC	○	E	●	○	○	●	●	●
Micropolis Corp.	RAIDION LTX 6.3 plus LM2100 Add-On Module	○	N	●	●	●	●	●	○
Perisol Technology	RaidSafe Plus 7 8MP	●	E	●	●	●	●	●	●
Procom Technology, Inc.	LANForce-5	●	E	●	●	●	●	●	●
Raidtec Corp.	FlexArray FX	○	DE	●	●	●	●	●	●
Storage Solutions, Inc.	Raca-Ray CM2+	○	N	●	●	●	●	●	●
StorageTek Distributed Systems Division	Nordique Open Storage Facility	●	N	●	○	○	○	○	●
Winchester Systems, Inc.	FlashDisk SCSI	●	DE	●	●	●	●	●	●


= BYTE Best.

● = yes; ○ = no; N/A = not applicable.

[1] Price includes five drives with 2 GB each for a total capacity of 10 GB or approximately 8 GB with parity.
[2] Price includes a sixth drive for a hot spare.
[3] Maximum performance is based on the number of transactions completed per time unit. Higher numbers indicate better performance.
[4] Total tested storage capacity excludes space for parity.

TESTED/MAX. TOTAL STORAGE CAPACITY (GB)[4]	RAID CONTROLLER	STANDARD RAID LEVELS SUPPORTED	RELIABILITY: REDUNDANT COMPONENTS	RELIABILITY: HOT-SWAPPABLE COMPONENTS	RELIABILITY: AUTOMATIC REBUILD SUPPORTED	RELIABILITY: HOT SPARE SUPPORTED	RELIABILITY: TYPES OF ALARMS SUPPORTED
8.4/28	CMD CRD-5000	0, 3, 5	DPF	DPF	●	●	VA
8/32	Clariion Proprietary	0, 1, 3, 5	DPFC	DPFC	●	●	VR
8/24	Mylex DAC960P2 dual-channel	0, 1, 5	DPF	DPF	●	●	VAR
8.4/12.6	CMD CRD-5000	0, 3, 5	DPF	DPF	●	●	VA
8.4/25.2	Mylex Backplane RAID Controller with Digital firmware	0, 1, 5	DPF	DPF	●	●	VR
8.4/26	DPT PM3224/W	0, 1, 5	DPF	DPF	●	●	VA
8.4/48	Mylex DAC960P 3-channel with AEMI	0, 1, 5	DPF	DP	●	●	VAR
10.5/30	Mylex DAC960PD dual-channel	0, 1, 5	DPF	DPF	●	●	VAR
8.4/24	Mylex DAC960P2 dual-channel	0, 1, 5	DPF	DP	●	●	VR
8.4/56.7	Micropolis GANDIVA	0, 1, 5	DPF	DPF	●	●	VA
8.4/12.6	CMD CRD-5000	0, 3, 5	DPFC	DP	●	●	VAR
8.4/24.8	CMD CRD-5000	0, 3, 5	DPFC	DPFC	●	●	VAR
8.4/22	Raidtec RUAC-II	0, 1, 3, 5	DPFC	DP	●	○	VAR
8.4/78	On-board Intel 960A RISC processor	0, 1, 3, 5	DPF	D	●	○	VAR
8.4/32	AMD 29000	0, 1, 3, 5	DPFC	DPFC	●	●	V
8.6/34.4	FlashDisk SCSI	0, 1, 3, 5	DPF	DPF	●	●	VAR

MAC OS	OS/2	NOVELL NETWARE 3.1X	NOVELL NETWARE 4.1X	UNIX	WARRANTY (YEARS/COVERAGE)	TOLL-FREE PHONE	PHONE	ON-LINE ADDRESS	INQUIRY NUMBER
●	●	●	●	●	1/PLR	(800) 872-2783	(619) 931-5500	service@artecon.com	1396
○	●	●	●	●	3/P	(800) 672-7729	(508) 898-6775	http://www.dg.com	1397
○	●	●	●	○	5/P	(800) 724-3511	(407) 263-3500	raid.support@conner.com	1398
●	●	●	●	●	1/PL	(800) 543-6098	(303) 442-4747	N/A	1399
○	●	●	●	●	5/PLF	(800) 786-7967	(508) 841-7000	N/A	1400
●	●	●	●	●	3/PLFR	(800) 322-4378	(407) 830-5522	http://www.dpt.com	1401
●	●	●	●	●	5/PL	(800) 966-6442	(508) 681-8400	N/A	1402
●	●	●	●	●	2/PLF	(800) 404-6342	(310) 247-0006	labarta@uu1201.megadrive.com	1403
○	●	●	●	●	3/PL	(800) 800-3475	(714) 453-6100	MicroNet@aol.com	1404
○	○	○	○	●	5/PL	(800) 395-3748	(818) 709-3300	http://www.microp.com	1405
●	●	●	●	●	1/PL	(800) 447-8226	(408) 738-1311	sales@perisol.com	1406
●	●	●	●	●	1/PL	(800) 800-8600	(714) 852-1000 x 414	http://www.procom.com	1407
●	●	●	●	●	2/PLF	N/A	(404) 664-6066	raidtec@interramp.com	1408
●	●	●	●	●	3/PLF	(800) 745-5508	(203) 325-0035	info@ssi.mhs.compuserve.com	1409
○	○	●	●	●	2/PL	(800) 323-3289 x 2443	(708) 434-1200	http://www.stortek.com	1410
●	●	●	●	●	1/PL	(800) 325-3700	(617) 933-8500	info@winsys.com	1411

Components:
D = drive
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F = fan
C = controller

Types of alarms:
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A = audible
R = remote

Types of security:
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N = none
E = enclosure

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F = freight to repair center
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Endian Issues

By supporting two memory-addressing modes, the PowerPC can run any OS or application

WILLIAM STALLINGS

One of the annoying but important differences among processors is the way they store data in memory. Most processors use one of two data-organization strategies, known as big-endian and little-endian, which are described in detail below. (The term *endian* is derived from a passage in Jonathan Swift's *Gulliver's Travels.*) Some machines, such as VAXes and systems based on the Intel x86 or the Pentium, are little-endian machines; others, such as the IBM System 370, machines based on the Motorola 680x0, and most RISC machines, are big-endian.

The differences between these strategies are relatively minor in terms of performance and efficiency. However, programmers and users alike need to be aware of endianness, because data ordered in one format isn't compatible with data ordered in the other. This isn't a problem when dissimilar platforms operate autonomously. But in a networked environment that encourages program portability and data interchange across platforms, this can create problems.

Byte-Ordering

Endianness has to do with the byte-ordering of multibyte scalar values. The concept arises when it becomes necessary to treat a multiple-byte entity as a single data item with a single address, even though it's composed of smaller, addressable units. When a programmer assumes a specific endian format and attempts to manipulate the individual bytes or bits within a range of multibyte scalar values, problems can occur.

The following description of endian byte-ordering illustrates such a dilemma. Suppose you have the 32-bit hexadecimal value 12345678 stored as a 32-bit word in byte-addressable memory at byte location 184. The value consists of 4 bytes, with the least significant byte containing the value 78 and the most significant byte containing the value 12. There are two ways to store this value: Start with value 12 in location 184, or start with value 78 in location 184.

The first mapping stores the most significant byte in the lowest numeric byte address; this is known as *big-endian* format. The second mapping stores the least significant byte in the lowest numeric byte address; this is called *little-endian* format. For a given multibyte scalar value, big- and little-endian formats are byte-reversed mappings of each other. In any machine, data aggregates such as files, structures, and arrays are composed of multiple data units, each with endianness. Thus, the conversion of a memory block from one style of endianness to the other requires knowledge of the data structure.

The figure "Three Memory Orders of Structure K" illustrates how endianness determines addressing and byte order. The structure in the listing "A Multibyte C Data Structure" on page 264 contains several data types. The memory layout in part (a) of the figure results from compilation of that structure for a big-endian machine; part (b) shows the results from compilation for a little-endian machine. In each case, memory is treated as a series of 64-bit blocks.

Several observations about this data structure can be made:

- Each data item has the same address in both big- and little-endian schemes. For example, the address of the doubleword that has the hexadecimal value 5455121347 48BEBF is 08.
- Within any given multibyte scalar value, the ordering of bytes in the little-endian structure is the reverse of that for the big-endian structure.
- Endianness does not affect the ordering of data items within a structure. Thus, the four-character word x3 in the listing exhibits byte reversal, but the seven-character byte array x4 does not. Hence, the address of each individual element of x4 is the same in both structures.

PowerPC Addressing Modes

The PowerPC is a *bi-endian* processor; that is, it supports both big- and little-endian addressing modes. This bi-endian architecture enables software developers to choose either mode when migrating OSes and applications from other machines. The OS establishes the endian mode in

Three Memory Orders of Structure K

Address	(a)	(b)	(c)
00	AA AB AC AD	AD AC AB AA	
04			AA AB AC AD
08	54 55 12 13	48 47 BF BE	54 55 12 13
0C	47 48 BE BF	13 12 55 54	BE BF 47 48
10	13 12 22 43	43 22 12 13	'E' 'W' 'O' 'P'
14	'P' 'O' 'W' 'E'	'P' 'O' 'W' 'E'	13 12 22 43
18	'R' 'P' 'C'	'R' 'P' 'C'	_ _ 06 19
1C	06 19	19 06	_ 'C' 'P' 'R'
20	35 36 37 38	38 37 36 35	
24			35 36 37 38

(a) Big-endian ordering of data. (b) Little-endian ordering as seen by a PowerPC processor (true little-endian ordering). (c) Little-endian ordering as found in PowerPC storage to minimize data swapping during memory accesses.

which processes execute; the default mode is big-endian. Once a mode is selected, all subsequent memory loads and stores are determined by the memory-addressing model of that mode.

To support this hardware feature, 2 bits in the MSR (machine state register) are maintained by the OS as part of the process state. One bit (ILE) specifies the endian mode in which the kernel runs when processing an interrupt; the other (LE) specifies the processor's current operating mode. Thus, the mode can be changed on a per-process basis, which is critically important for foreign OS emulation.

When an interrupt occurs, the processor saves the current MSR and loads an MSR for the interrupt-processing routine. The value of the ILE bit in the old MSR is copied into the LE bit in the new MSR. When execution resumes in the interrupted process, its MSR is reloaded with its LE and ILE bits intact.

Byte Storage

The PowerPC architecture specification does not dictate how a processor should implement little-endian mode. It specifies only the view of memory that a processor has when operating in little-endian mode. When converting a data structure from big- to little-endian, the processor can either implement a true byte-swapping mechanism or use some sort of an address-modification mechanism. Current PowerPC processors are all big-endian by default and use address modification to treat data as little-endian.

Part (c) of the figure "Three Memory Orders of Structure K" shows how memory is laid out when data is stored in little-endian form for current PowerPCs. This is not a true little-endian organization as it is usually defined. Rather, it is designed to minimize the data manipulation required to convert from one endian format to another.

Note that 64-bit scalars are stored in the same formats on the PowerPC. To accommodate smaller scalars, a technique known as *address munging* is used. When the PowerPC is in little-endian mode, it transforms the 3 low-order bits of an effective address during a memory access. These 3 bits are XORed with a value that depends on the transfer size: 0x100 for 4-byte transfers, 0x110 for 2-byte transfers, and 0x111 for 1-byte transfers. The table "PowerPC Address Munging" below lists the possible combinations.

For example, the 2-byte value 0619 is stored at location 1C in big-endian mode. In little-endian mode, it's viewed by the processor as still being stored in location 1C, but in little-endian mode. In fact, the value is still stored in big-endian mode, but at location 1A. When a transfer occurs, the system must do an address unmunging and a byte transfer to convert data to the form expected by the processor. The processor generates effective addresses of 1C and 1D for the 2 bytes. These addresses are munged (XOR with 110) to 1A and 1B. The data bytes are retrieved, swapped, and presented as if they were found in the unmunged addresses 1D and 1C.

A Multibyte C Data Structure

```
struct{
        int      x1;      //0xAAAB_ACAD                       word
        int      pad;
        double   x2;      //0x5455_1213_4748_BEBF             doubleword
        char*    x3;      //0x1312_2243                       word
        char     x4[7];   //'P','O','W','E','R','P','C'       byte array
        short    x5;      //0x0619                            halfword
        int      x6;      //0x3536_3738                       word
} k;
```

Unaligned Data

This address-munging technique does not work cleanly with data that is not aligned on its natural boundary (e.g., a 4-byte value is aligned if its address is divisible by 4). When a value is unaligned, its storage in little-endian mode might result in the value being split into two noncontiguous parts. When an unaligned access is attempted in little-endian mode, an alignment interrupt occurs. This causes the processor to transfer to the system-alignment error handler, which handles the interrupt by a series of load-and-store operations that emulate the memory access.

Because of the exception processing, accessing unaligned little-endian data can seriously degrade a processor's performance. The simplest fix is to properly align little-endian data. But this might not be possible for certain processes, such as an x86 emulator, which accesses variable-length x86 instructions in memory.

But another solution is in the works. New versions of the PowerPC 603 and 604 will handle misaligned little-endian accesses in hardware, and thus handle an alignment interrupt the same way as in big-endian mode. They will be able to operate in little-endian mode without incurring a performance penalty.

Implications

The PowerPC architecture is organized for big-endian storage and processing. It also provides a transparent method for dealing with little-endian programs and data.

This enables a PowerPC processor to run a program written for little-endian memory organization simply by recompiling the application on the PowerPC, which reduces the program-porting work required. When the recompiled program is run on the PowerPC with the LE bit set, the processor's address-mapping facility makes all data structures appear identical to the layout that the program saw on a little-endian machine. This ability to handle bi-endian address modes makes the PowerPC processor ideal for hosting different OSes, such as on the CHRP (Common Hardware Reference Platform). ■

POWERPC ADDRESS MUNGING

4-byte Transfers (XOR with 100)		2-b te Transfers (XOR with 110)		1-b te Transfers (XOR with 111)	
Original Address	Munged Address	Original Address	Munged Address	Original Address	Munged Address
000	100	000	110	000	111
001	101	001	111	001	110
010	110	010	100	010	101
011	111	011	101	011	100
100	000	100	010	100	011
101	001	101	011	101	010
110	010	110	000	110	001
111	011	111	001	111	000

William Stallings is an independent consultant. This article is based on material from his most recent book, Computer Organization and Architecture: Designing for Performance, Fourth Edition *(Prentice-Hall, 1995). You can reach him on the Internet at stallings@acm.org or on BIX c/o "editors."*

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The Joy Of J

One line of J can do the same work as hundreds of lines of Pascal or BASIC

DICK POUNTAIN

If you are involved in mathematical programming then you need to know about the J programming language. Even if you perform less abstract tasks like analyzing financial data from a corporate RDBMS (relational database management system), you will find J interesting.

J is the modern successor to APL, a language that developed a cult following among some corporate IBM mainframe users in the 1960s as a rapid and powerful (but cryptic) data processing tool. APL suffered from its use of an unorthodox character set (that included Greek characters, among others), which didn't sit well on ASCII text displays and keyboards.

J is a truly new language by APL's author, Kenneth E. Iverson, and implemented by his son Eric and colleague Ronald Hui. It's available on a wide range of platforms including DOS, Windows, OS/2, Unix, and Macintosh. J is more than just an ASCII-fied APL, but it retains the same fundamental principles. Ironically, Windows and the Mac could now support APL characters, but J sticks to ASCII characters—and is the better for it.

I've been using the Windows release of J version 2.05, which can be a powerful calculating engine for Visual Basic programs. The J system provides a DDE server which you can include in your VB (Visual Basic) programs, allowing you do the math in J while writing the user-interface and file handling parts of your application in VB. J also comes with its own Windows-based development system so you can write stand-alone J programs that employ the Windows interface on their own account, including DDE, OLE, ODBC (Open Database Connectivity), VBX (Visual Basic custom controls), and all the other trimmings.

J is an interpreted language, though this fact usually has little impact on J's processing speed. The language's primitive functions are written in C and are highly optimized. They will often run faster than the obvious equivalents you might write yourself.

J employs a functional style in which expressions are evaluated from right to left. It does support dyadic operators (with both left and right arguments) such as + so that arithmetic looks quite familiar. There is only one data structure in J: the array. A number like 2 is treated as an array of rank 0, and text is an array of characters. You create new named objects simply by assigning them values (this includes programs). J allocates and frees memory automatically and invisibly, and the only limit on the size of an object is available memory.

The Language

You could use J like a calculator to do statistical cluster analysis

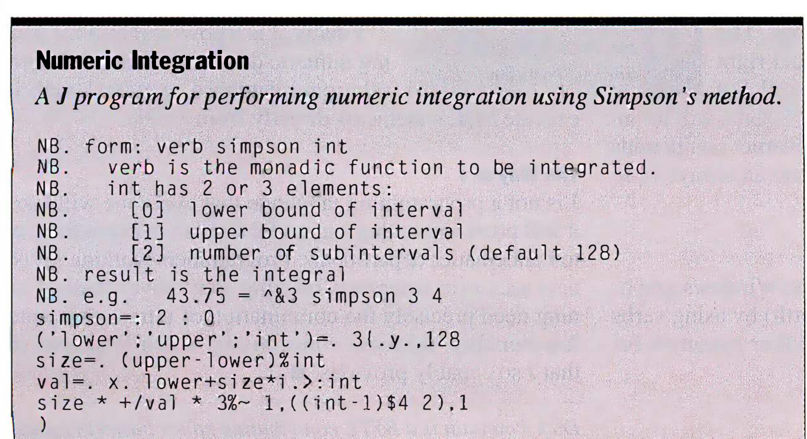
The syntax of J is extremely simple and regular; all functions have the same priority; parentheses are the only way to alter execution order. J's components are named using terms taken from English grammar: Functions are called verbs, constants are called nouns, adverbs and conjunctions modify the action of verbs. In fact, J is an executable mathematical notation, and Iverson has written a series of math textbooks, up to and including vector calculus, using J as the descriptive notation.

The J language consists largely of 70 or so verbs. Although J has abandoned APL's hieroglyphics, its verbs still have cryptic two-character names like >. or #:. Here is a one-line program to compute Hellerman's distance-squared similarity measure for a matrix of any size :

```
dsqt=. +/"1@*:@(-"1/~)
```

You could be forgiven for mistaking it for line-noise. To be fair, J doesn't have to look this scary; `mean=. sum % count` is a perfectly good J definition. The point is, someone fluent in J could hack `dsqt` from the keyboard during an interactive session, using J like a calculator to do statistical cluster analysis.

Math problems that would take hundreds of lines of Pascal or BASIC take one line of J. So, J is not a



Numeric Integration

A J program for performing numeric integration using Simpson's method.

```
NB. form: verb simpson int
NB.   verb is the monadic function to be integrated.
NB.   int has 2 or 3 elements:
NB.     [0]  lower bound of interval
NB.     [1]  upper bound of interval
NB.     [2]  number of subintervals (default 128)
NB. result is the integral
NB. e.g.   43.75 = ^&3 simpson 3 4
simpson=: 2 : 0
('lower';'upper';'int')=. 3{.y.,128
size=. (upper-lower)%int
val=. x. lower+size*i.>:int
size * +/val * 3%~ 1,((int-1)$4 2),1
)
```

language for the faint of heart. Learning the syntax and semantics of all the primitives will take time, but the reward is that you can then do extraordinarily intricate array and matrix computations that would be difficult or impossible in, say, a spreadsheet.

Most of the verbs either generate arrays or perform operations on elements of arrays. You can combine primitive operations by using adverbs to form new operations. For example, `i. 89` generates a list of the integers up to 89, and + is the humble sum operation. The adverb /—called "insert"—causes its left argument to be inserted between the elements of its right argument. So `+/ x` means sum the whole list `x`, and hence `+/ i. 89` sums all the integers up to 89. Or again, the adverb "tie" is represented by `. Its action is to combine several verbs into one (called a gerund). The gerund +`*`– when applied to `1 2 3 4` will calculate 1+2*3–4. If you need to use such constructs more than once, you can give them a name, as in

```
ger=. +`*`-
```

where =. is just the assignment operator. To save names permanently, you store the text into script files, which when loaded execute as though typed from the keyboard.

Unlike APL, J supports conventional control structures like `if...then` and `while`. You could define `factorial` as:

```
factorial=. 3 : 0
a=. 1
while. y. > 1
do. a=. a*y.
  y.=. y. - 1
end. a
)
```

(where `y.` refers to the verb's right argument), though a hardened J-bird would probably prefer the cryptic definition:

```
factorial=. 1:`(]*factorial@<:) @. *
```

Actually it's pointless to do either, as factorial is a built-in primitive verb, !.

Another J innovation is the concept of a "locale," or private name space, so that `mydef` defined in locale A is different to `mydef` in locale B. Locales enable you to write modular applications while avoiding name clashes.

Finally, an important (if rather unaesthetic) feature of J is the "foreign conjunction" which is the way you do system dependent, nonmathematical things. The conjunction `!:` takes two numbers as left and right arguments to produce a verb which is a system call. For example, `1!:0` is the directory call, so `1!:0 '*.txt'` will list all the text files in the current directory. This construct compounds J's unreadability, though a diligent programmer can always write a library of meaningful synonyms.

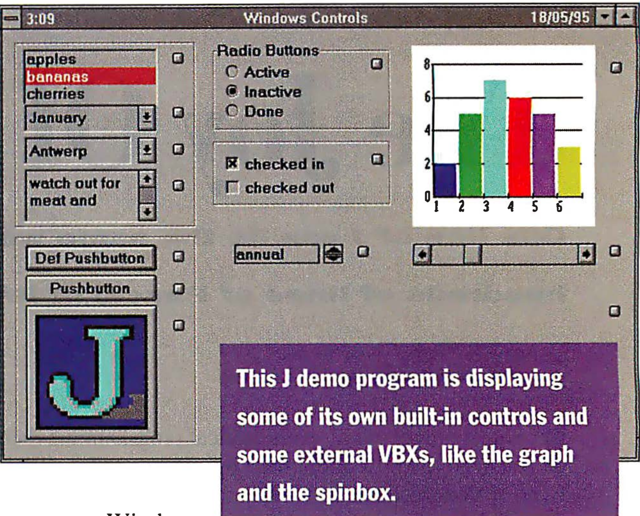
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fax: (612) 470-9202
amfaust@aol.com

Windows and J

You can write J programs that fully exploit the Windows graphical interface (or the Mac, or OS/2, and so forth) by using verbs called `wd` commands (actually, `wd` is a friendlier synonym for `11!:0`). For example,

```
wd 'mb "Dick says" "Hello!" ;'
```



This J demo program is displaying some of its own built-in controls and some external VBXs, like the graph and the spinbox.

pops up a Windows message-box with title "Dick says" and content "Hello." J's interpreted nature doesn't mean that windowing operations are slow. As with VB, when a window is open it's mostly Windows GDI (Graphical Device Interface) code being executed.

J's Windows driver provides 10 control classes: button, edit, listbox, combobox, scrollbar, static text, isigraph, isipicture, isiole, and vbx. Isigraph is a graphics box, and J contains many graphics commands (e.g., gpolygon) to draw in it, while isiole is the graphical presentation for an embedded OLE object. The vbx control class allows you to add VBX controls into J programs. J can drive other windows applications via DDE links and OLE 1 linking and embedding, but it does not yet support OLE 2.

J's `vedit` verb let's you visually edit any parent window and its controls (i.e., by dragging with the mouse), and J's publishers have used it to good effect in writing a simple but effective forms editor supplied with J. The editor lets you build an application by choosing controls from a menu, like a mini-VB.

Though J's Windows interface is powerful and well thought out, it's still easier to write complicated user interfaces using VB, and J lets you do just that. Including JDDE.FRM and JDDE.BAS in your VB project gives you a DDE link to a J server, along with an attendant API. For example, the VB routine `jdo(s$)` executes its string argument as an expression in J, while a variety of data exchange routines will retrieve values from J and format J-style arrays in VB-style arrays. You can even make an executable version of your VB application that includes a J run-time server.

Finally, J is a powerful tool for manipulating numeric data held as tables in a corporate relational database. A `ddsql` verb lets you execute SQL statements directly from J code.

The Way of J

J is not a programming language that everyone will take to, but it will prove interesting and useful to more than just those confined to mathematics departments. Programmers working in such business sectors as insurance, banking, derivatives trading, and planning need precisely the combination of ultrasophisticated math functionality, database connectivity, and a Windows interface that J so capably provides. ■

Dick Pountain is a BYTE contributing editor based in London, U.K. You can reach him on the Internet or BIX at dickp@bix.com.

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Springtime at Sun

SunSoft's experimental OS contains clues to the future of Solaris

DOUG TAMASANIS

On March 21, the first day of spring, SunSoft released to the research community a "concept car" for the next generation of OSes. Called, naturally enough, Spring, it is the fruit of labor begun in the mid-1980s. The company decided to produce a new OS, unconstrained by the requirement to support legacy software, that was distributed, multithreaded, and fully object-oriented.

Although Spring will not be the next version of Solaris, many of the concepts found in Spring will eventually migrate to SunSoft's commercial OS. Technology developed for Spring is the foundation for Sun's DOE (Distributed Objects Everywhere). Pieces of Spring have also found their way into the object technology being developed by the OMG (Object Management Group).

Defining Interfaces

A Spring object is an abstraction containing a state and a set of methods to manipulate that state. SunSoft calls the description of the object and its methods an interface. This interface defines interactions between an object providing a service (i.e., a server) and an object using the service (i.e., a client).

To maintain openness and not tie developers into a single programming language, SunSoft developed an IDL (interface definition language) to define the interfaces. An IDL compiler converts IDL into three pieces of code in the chosen target implementation language: the IDL interface, client-side stub code, and server-side stub code (see the figure "Spring IDL").

The IDL interface is language-specific. In C, for example, this is a header file with method definitions, constants, and types defined in the IDL interface. Client-side stub code is dynamically linked to a client's program, allowing access to an object implemented in another address space or on another machine. Server-side stub code is linked into an object manager to translate incoming remote object invocations into the run-time environment of the object's implementation.

These three pieces of code enable objects in a particular language to treat IDL-defined objects as if they were native-language objects. Thus, if your client object were in C++, you would use an IDL-to-C++ compiler to produce C++-compatible header files and stub-code objects. If a server object's implementation is in C, you would have to use an IDL-to-C compiler to generate the server-side stub code to transform incoming calls into corresponding C procedure invocations on the C objects corresponding to the IDL objects. Spring's IDL forms the basis of the IDL adopted by the OMG.

Invoking Objects

All Spring interfaces are defined in IDL, yet IDL doesn't define anything about how to implement operations on an object or how to convey operation requests to an object. To use an object, you merely invoke operations defined in its interface. The client and server object don't need to know if the object on the other side of the interface is in the same address space, in another address space on the same machine, or on another machine.

The IDL-generated stubs use Spring's subcontract mechanism to communicate. Subcontracts provide a flexible way to control the implementation of object invocations, the transmission of object references between address spaces, the release of object references, and similar object run-time operations. Other uses include the implementation of a number of object run-time mechanisms.

Server-based objects typically use the Spring doors mechanism to communicate between client and server (see the figure "Spring Doors" on page 272). Most subcontracts optimize the case when the client and the server are in the same address space by performing a local call rather than calling through the kernel.

Spring also supports serverless objects, where the entire state of the object is always in the client's address space. When Spring passes a serverless object between address spaces, it copies the object's state to the new address space. Passing a serverless object is akin to passing a struct, while passing a server-based object is similar to passing a pointer to its remote state.

Spring IDL

Spring Kernel

Spring's microkernel design has two components that run in the kernel mode. The VMM (virtual memory manager) provides the code facilities for paging virtual memory. The microkernel proper is called the nucleus.

The nucleus supports three abstractions: domains, threads, and doors. Domains are analogous to processes in Unix. Threads execute within domains. Typically, each Spring domain is multithreaded, with separate threads performing different parts of an application. Doors support object-oriented calls between domains. A door describes a particular entry point to a domain, represented by both a program counter and a unique value that is chosen by the

domain. The object server typically uses this value to identify the state of the object.

Each domain has an associated table of doors to which it has access. Multiple door identifiers in different domains may reference a single door. Possession of a valid door gives the processor the right to send an invocation request to that door. In the target domain, all invocations on a given door are equivalent, specifying only that the invoker has somehow acquired a suitable door identifier. There is no knowledge of who the invoker is or which door identifier it used.

Spring Doors

Spring uses network proxies to extend the nucleus invocation mechanism and transparently connect the nuclei of different machines. These proxies are normal user-mode server domains and receive no special support from the nucleus. One Spring machine can include several proxy domains that speak different network protocols.

Proxies transparently forward door invocations between domains of different machines. When a client on machine B invokes door Y, machine B forwards the call over the network to proxy A. Proxy A does the door invocation, and the door invocation arrives in the server domain. Neither the client nor the server need be aware that proxies exist. The client just performs a normal door invocation, and the server just sees a normal incoming door invocation.

Spring maps door identifiers into network handles for transmission over the network and remaps back to the door when the door identifiers arrive from the network. A network handle contains a network address for the creating proxy and a set of bits to identify a particular door that is exported by this proxy.

Spring implements an extensible, demand-paged virtual memory system that separates caching pages from the tasks of storing and retrieving pages. A per-machine VMM handles mapping, sharing, protecting, transferring, and caching of local memory.

Most clients of the virtual memory system deal only with address space and memory objects. An address-space object represents the virtual address space of a domain. A memory object is a memory abstraction mapped into address spaces, such as a file object. The VMM implements address-space objects.

A memory object has operations to set and query the length, and to bind to an object. Binding ensures that two equivalent mapped memory objects will share the data cached by the VMM. There are no page-in/page-out or read/write operations on memory objects. The Spring file interface provides file read/write operations but not page-in/page-out operations. By separating the memory abstraction from the interface providing the paging operations, the memory-object server and the pager-object server can be in different machines.

The VMM obtains data by invoking a pager object implemented by an external pager. An external pager performs coherency actions by invoking a cache object implemented by a VMM. When a pager asks a VMM to map a memory object into an address space, the VMM must be able to obtain a pager object to let it manipulate the object's data. Association between the pager and a cache object is necessary to ensure coherency. Typically, there are multiple pager-cache object channels between a given pager and a VMM. The external pager implementing the memory object maintains data coherency between different VMMs that are caching a memory object.

Coherently caching data using more than one VMM requires a two-way connection between the VMM and an external pager or file server. The VMM needs a connection to the external pager to let the VMM obtain and write out data, and the external pager needs a connection to the VMM to let the provider perform coherency actions. Spring employs pager and cache objects to represent these connections.

What's in a Name?

Most OSes have several name services tailored for specific kinds of objects (e.g., files, users, and printers). Spring provides a uniform naming service allowing any object to be bound to any name. Use of a common name service eliminates construction of name spaces by all object implementations. But remember that Spring is completely object-oriented, so it can support multiple name servers.

Spring allows association of objects with a name that is in a context or name binding. Contexts are themselves objects, containing name-to-object associations that clients use to perform naming operations. Objects can be concurrently bound to different names in different contexts or not bound to any name. By binding contexts in other contexts, Spring creates a naming graph. This is a directed graph with nodes and labeled edges, where the nodes with outgoing edges are contexts.

Unlike naming in traditional systems, Spring contexts and name spaces are first-class objects. That is, you can directly access and manipulate them. Also, Spring objects derive persistence through naming. Generally, applications will acquire their objects from the name service. If the region of the name space where the object is found is persistent, the object will also be persistent.

Spring Is Not Unix

Spring is not Unix, but it does provide binary compatibility for a number of Solaris programs by using a Unix-emulation subsystem. The emulation runs as user-level code and employs no Unix code. The implementation consists of two components: a shared library dynamically linked with each Solaris binary and a set of Unix-specific services exported via Spring objects implemented by a Unix process server in a separate domain.

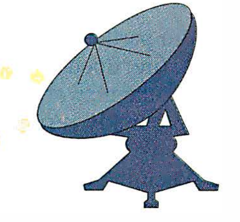
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The Unix process server implements functions that are not part of the base Spring system and which cannot reside in the shared library due to security reasons. The system provides enough Unix emulation to support standard utilities, such as `make`, `vi`, `csh`, X Window System, and various Solaris programming tools used by the Spring developers.

Running Unix in emulation would clearly be unacceptable in production environments, which is why SunSoft wants it known that it does not intend to make Spring the next version of Solaris. The company has learned its lesson from the porting effort that got it to Solaris. However, Spring demonstrates just what you can do if given the chance to build a sparkling-new OS with modern software engineering methods, without worrying about legacy systems. ■

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Tuning In to ISDN

Wireless transmission methods help speed ISDN deployment

JEFFREY FRITZ

Dick Tracy's famous wrist radio was way ahead of its time as a portable communications device. It allowed Tracy to be anywhere in the city and still stay in contact with the people and resources he needed to do his job. By contrast, digital telecommunications services are anything but portable. Most are lashed by twisted pair to wall-mounted faceplates. The lack of portability reduces flexibility and restricts access. It also creates dependency on outside agencies, like the telephone carriers, to provide service to the faceplate.

As with most digital services, ISDN has been a tethered service requiring physical connections to the fiber- and copper-based telephone network. Considering the wide range of voice, video, and data applications it supports, ISDN's lack of mobility has been extremely constraining. Fortunately, a new form of ISDN, called ISDN Radio, is breaking the copper umbilical cord and offering users unheralded communications freedom.

ISDN Radio comes in two flavors: satellite and radio (see the figure "ISDN Radio/Satellite Configurations" below). Satellite ISDN is based on VSAT (Very Small Aperture Terminal) technology. VSAT uses transportable satellite link equipment and relatively small uplink/downlink dishes. Connections are made using leased or call-based satellite channels. Radio ISDN uses specialized modems called spread-spectrum modems which distribute the signal over a wide bandwidth, reducing interference and improving security. While satellite ISDN can span continents, radio ISDN's range is limited. It is broadcast primarily via transmitters operating on 1 W or less. The low power restricts the range, depending on antenna height and terrain, to a maximum radius of 30 miles.

Quickness Counts

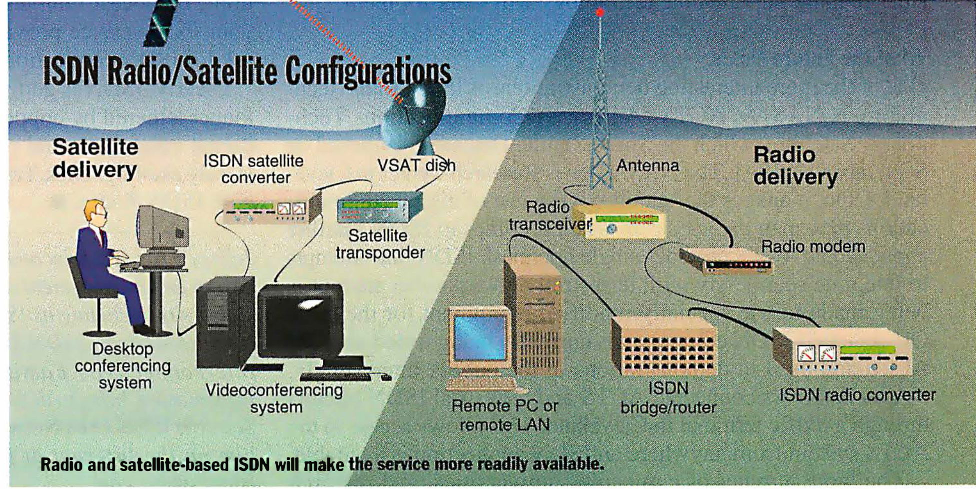
Among ISDN's biggest drawbacks are long installation time, distance limitations, and a lack of ubiquity. ISDN Radio can help resolve each of these flaws. While terrestrial ISDN orders take days or even weeks to process, ISDN Radio equipment can be set up quickly. It's not unusual to have service in place within 24 hours. This makes ISDN Radio especially valuable when unexpected events take place, such as a network outage, an urgent site coming on-line, a network demonstration that was scheduled without advance notice, or a last-minute video conference.

It's also possible to have ISDN Radio service in locations where terrestrial ISDN is not available. Where there is no terrestrial ISDN, ISDN Radio can step in as an extension service. ISDN Radio's transportability can bring ISDN to a non-ISDN location. It can also extend ISDN past the infamous "last mile," which occurs when ISDN is available locally, but the remote site exceeds the 18,000-foot distance from the central office.

That's where ISDN service delivered over a satellite link can help. "Satellites can seamlessly extend ISDN from any ISDN public network to remote locations that do not have access to ISDN terrestrially," says Thomas von Deak of NASA's Lewis Research Center. "This is important because ISDN will form the basis for the first implementation of the NII [National Information Infrastructure] and the GII [Global Information Infrastructure]."

Reaping Other Benefits

ISDN Radio adds more than basic network connectivity. By nature, ISDN Radio is redundant. Connections are not made over the terrestrial telephone network, but through radio or satellite. The local telephone company is either out of the loop entirely, or ancillary to the connection. This makes terrestrial outages of far less consequence. Network administrators who are challenged to keep their networks alive no matter what the situation will find



Radio and satellite-based ISDN will make the service more readily available.

ISDN Radio particularly attractive. Should a disaster such as earthquake, fire, flood or tornado disrupt terrestrial-based WAN connections, the network manager can call on an ISDN Radio provider to quickly restore services. The company may also choose to have ISDN Radio in hot standby, or even in active service. When the terrestrial connections go down, the ISDN radio links can be pressed into service.

Broadcasters realize that ISDN can provide enhanced audio quality without the need for multiple analog lines or audio frequency shifting equipment. A single BRI (Basic Rate Interface) line without compression can provide 7.5-kHz bandwidth audio. For comparison purposes, 7.5 kHz is equivalent in quality to a decent AM station. Increasing audio bandwidth to 15 kHz, comparable to FM quality, or adding stereo can be achieved with multiple ISDN lines or compression. This makes ISDN ideal for remote broadcasts that sound as if they originated in the studio.

Points to Ponder

ISDN Radio is not without its disadvantages. It requires extra equipment, some of which is fairly expensive. It takes special know-how to set up, operate, and maintain the service. Satellite time can be expensive, and satellite channels require access to a satellite provider. ISDN Radio is subject to the same limitations as any radio service. Interference and poor signal quality can cause problems. Most importantly, satellite delays adversely affect the quality of ISDN Radio's service.

Satellite links introduce a fair amount of delay (see "When Timing's Critical" above). If severe enough, delays can garble voice transmissions, scramble video, and collapse WAN connections. For example, a terrestrial ISDN BRI (Basic Rate Interface) delays the signal about 10 milliseconds. An international terrestrial circuit experiences delays of 140 ms. A single satellite hop has a marginal range one-way delay of 260 ms. Bidirectionally, satellite delays can be well over 500 ms. This puts satellite delays in the unacceptable range for some applications.

Delays can cause problems for isochronous applications that require audio and video synchronization, or are intolerant of disruptions in information flow. Delays can also cause problems for network applications. If the delay is long enough, the network protocol may assume that the communications link has been lost and time out the session. Even a less drastic network response to delays can cause unnecessary retransmissions, collisions and, in severe cases, broadcast storms. Users considering ISDN Radio for network or time-sensitive applications should take steps to make sure that the technology will work for them.

What the Future Holds

One of the more interesting demonstrations of ISDN Radio technology is NASA's ACTS (Advanced Communications Technology Satellite), which the Space Shuttle Discovery launched on September 12, 1993. The NASA Lewis Research Center in Cleveland, Ohio, manages the satellite; it is a test of digital communications that span the spectrum when it comes to ISDN satellite applications. ACTS provides single hop mesh ISDN that attempts to integrate seamlessly with terrestrial networks. No attempt is being made to use specially modified equipment for the tests. Off-the-shelf ISDN equipment is currently being tested over the ACTS and used in demonstrations to the public. Interestingly, NASA has cross connected ACTS and terrestrial ISDN circuits through a traffic terminal in Cleveland. This allows access to the ACTS system from anywhere an ISDN connection is available.

The large number of companies, universities, and research organizations that use ACTS includes Comsat, the U.S. Army Research Labs, the National Telecommunications and Information Administration, and NIST (National Institute of Standards and Technology). There are several interesting technology examples being tested on ACTS. In one experiment, Corporate Computer Systems, JPL (Jet Propulsion Labs), and CBS Radio are demonstrating ISDN high-quality audio transmissions. The North American ISDN Users' Forum has been testing a PC-based multimedia teleconferencing system over a VSAT-transportable link back to the Lewis Research Center, the JPL, and other sites.

One particularly interesting application is a disaster-recovery and communications-augmentation experiment. Ohio University conducted tests to help Huntington Bank recover from a simulated disaster that created a total loss of communications. ACTS was used to transmit financial data such as deposits, account balances, and transfers of funds. The experiment measured the ability to switch over to a backup communications system within an acceptable period of time as well as the economical advantages of using ISDN satellite as a backup system.

Bellcore is conducting experimentation with satellite-based PCS (Personal Communications Services). The goal of this research effort is to demonstrate a satellites' capabilities for enhancing ground-based personal communications voice and data services. The experiment will determine the ways in which local exchange network providers can interface to wireless service providers and the kinds of services that should be offered.

Finally NIST has connected the ACTS ISDN system to the government's FTS2000 digital communications infrastructure and is investigating interoperability issues between the terrestrial and satellite systems.

Given encouraging results from ACTS and early user successes, ISDN Radio appears worthy of consideration as a vehicle to provide redundant network backup, remote WAN connections, broadcast remotes, or world-wide videoconferencing. If your local service provider gives you a blank stare when you ask for ISDN connections, ISDN Radio could be your answer.

Clearly, ISDN is getting more interesting by the moment. No longer tethered by copper umbilical cords, the freedom to have digital voice, data, and video services at any time and any place is truly exciting. Dick Tracy would have been very much at home with ISDN Radio. ■

WHEN TIMING'S CRITICAL

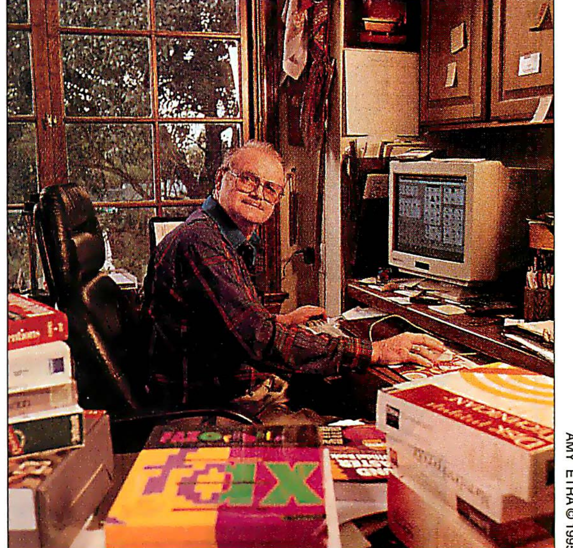
Signal delays pose problems for isochronous applications.

Service	Delay (ms)	Quality of Service
National T-1 Service	1	Acceptable
Terrestrial ISDN	10	Acceptable
National analog service	25	Acceptable
International terrestrial service	140	Acceptable
Single hop satellite	260	Marginal
Bidirectional satellite	520	Unacceptable

Jeffrey Fritz is a telecommunications engineer responsible for the design and management of data communications for West Virginia University, including its ISDN applications lab. He is the chair of the North American ISDN Users' Forum Enterprise Network Data Interconnectivity Family. Mr. Fritz also chairs the National Information Infrastructure Working Group. He is the author of Sensible ISDN Data Networks *(WVU Press, 1992). You can contact him on the Internet at jfritz@wvnvm.wvnet.edu or on BIX at editors@bix.com.*

JERRY POURNELLE

Of COM Ports and Digital Frogs


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Jerry attends an education conference and then learns a thing or two about communications software in Windows 95

It has been a busy month. First off, I was the keynote speaker at the Association for Media and Technology in Education in Canada, which met this year at the University of Guelph. The city of Guelph is about an hour from Toronto, just far enough that it hasn't lost the feel of a university town in a rural setting; it reminded me of Iowa City in the 1950s. AMTEC is one of the older organizations promoting technology in education.

A major issue in education technology is distance learning. Studies by the Danish Ministry of Education conclude that the critical cost factor is how to make low-paid people—such as students—do the work formerly done by high-paid people. Danish and other studies also indicate that the general result of applying high technology to education is to increase educational quality, but at increased costs; it's rare when high-tech education saves money. That's a big disappointment in this era of falling education budgets.

Guelph is the major center of Canadian veterinary education. Lifelearn V., a private company in a joint venture with the university, has developed one way to both increase education quality and save money. They've got the first really practical applications for CD-I (CD Interactive) I've seen.

Lifelearn uses CD-I for multiple reasons. First, it's easy to use, and it requires no computer experience. Second, they can give away the CD-I box, which outputs NTSC video into a TV set, as part of the course. Finally, since many parts of the course materials feature real-time demonstrations, they want interactive full-motion video, which CD-I supplies nicely.

Continuing education is important in many professions. Sometimes it does some good, but, alas, all too often continuing education workshops degenerate into a series of Mickey Mouse sessions at which you get your ticket punched while vacationing on Maui or a Phoenix golf course. Some of those refresher workshops may be valuable, but Lifelearn offers an alternative. For less money, you can get the Interactive Multimedia Self-Study Modules prepared by veterinary experts accredited in both Canada and the U.S. Because it's on CD-I and audiotape, everyone in the clinic can take the machine home and go through the course materials. Course content varies from canine dental surgery through cardiology to dairy farm health management.

The Lifelearn CD-I system impressed me a lot. I'm certain that soon enough this kind of thing will be available—from one source or another—for dozens of professions. Meanwhile, if you're a veterinarian, you should know about the Interactive Multimedia Self-Study Modules.

Of course, there's an awful lot of pure hype about educational software. One (very badly produced) video I have spends half an hour telling about its problem-solving approach to education. Principals wax eloquent on how this launches high school students into lifetime learning. Other teachers tell us that the kids just love this stuff because it's not a boring book. Then we're informed that "problem solving is a very unique process." You can re-create electronically just what the student did to solve the problem.

What they're selling is authoring materials.

continued

ILLUSTRATIONS: EMILY THOMPSON © 1995

The value of the course will depend entirely on the teacher choosing the right problems to solve. While this may be valuable, it's hardly new.

This is all of a piece with the new education fad that says it's not important what kids learn. "We teach them how to think, not what to think." That sounds wonderful until you ask the next question: What is it they are to think about? And must they discard 2000 years of history—largely a history of problem solving?

Long years ago when I was a student, there was an education fad called general semantics. By studying the science of meaning, we were going to solve all human problems. Like all education fads, this one contained some valuable (if not always original) insights. One of these was that humans are time binders: they don't have to learn by making the same mistakes their ancestors did. We don't have to discover all facts for ourselves.

It's clear that learning facts without understanding isn't much of an education, and students are highly motivated to play games rather than study facts. But the weakness of the problem-solving approach to education is that it's no use solving problems unless they are related to the real world; and while the ability to think things through is valuable, sometimes what you need is to be told how someone else did it.

We tend to learn to do what we've already done. Every sports coach understands this. Left to themselves, students generally won't stumble onto proper technique. Take fencing as an example. Hand a class of beginners weapons and protective equipment, and in a week, they'll have "problem-solved" their way to so many bad habits they may never be any good.

I've recently seen essays criticizing the hypertext concept as undeliverable hype. Now it's true that despite a decade of work and some financing from Autodesk, Ted Nelson and his associates didn't finish Xanadu; but that's not the main problem with hypertext.

The big problem is the hypertext concept itself. For example, there's Nelson's book, which you can start reading anywhere you like and read the chapters in any order. That's only a book, of course. His ultimate vision was Xanadu, computers connected on-line to give you all knowledge as hypertext, so that you could read everything in the world in any order you liked: the universe of knowledge without any imposed structure.

It's attractive. We've all had the experience of going to an encyclopedia to look for one thing and emerging hours later. We often learn something that way, too; but I suspect the ones who learn the most are those who came to the encyclopedia with an intellectual framework into which they could put their new knowledge. Unorganized facts aren't science, they're merely anecdotes; it takes structured theory to turn anecdotes into data.

We don't have Xanadu yet, but we do have hypertext CD-ROMs. Most have little or no structure. You can peel off facts in any order you like. These may be useful to experts well grounded in the subject matter, but in the hands of beginners, they're more likely to be tools for amusement rather than for learning. The same is true of unstructured problem-solving education. It may generate enthusiasm, but all too often, it's the enthusiasm of the beginning fencer handed weapons and a mask.

Lifelearn's educational approach is successful because they're building on a solid foundation. They don't teach the basics of veterinary medicine, nor are they concerned with a general education in problem solving. What they do is show already competent people new developments in their field, along with practical techniques they can use.

Lifelearn has a large staff and a big budget. Digital Frog International has neither.

I don't know how many frogs have been slaughtered to provide subjects for dissection in high school labs, but Digital Frog's "frog-friendly software" may help to change that. The Digital Frog is a CD-ROM developed by students on a shoestring; their entire capital investment, including a Power Mac, was under $10,000.

They used a high-quality 35mm macro camera to take pictures of each stage of the dissection of a frog by an expert. Shots were made from many angles, and the whole thing was synchronized with a lecture. The pictures were digitized by turning the rolls into Photo CDs. They used an inexpensive JVC camcorder to capture images for QuickTime movies of frog activities, such as a frog catching a fly.

Then they added QuickTime animations, drawings, and diagrams, with excellent narration. The result is far more instructive—at least to me—than dissecting a frog, and there's no formaldehyde smell. The Digital Frog won the "best of show" award at AMTEC, and rightly so.

continued

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If you teach high school biology, you'll definitely want the Digital Frog. It's an excellent example of what new technology and ingenuity can do for education.

My latest trip was to Microsoft for another dog and pony show about Windows 95. I've been using W95 on my main system for about three months now, going through a dozen "builds" as Microsoft fixes reported bugs. I have to say I like it; in particular, I like the user interface better than those of either Windows or OS/2. More important, though, it works.

There are some anomalies. I'll get to one of them in a moment; but the important thing is that I've had far less trouble getting used to W95 than I did Windows itself. Longtime readers will remember many columns in which I was screaming in frustration. That hasn't happened with W95.

One anomaly involves QEMM. W95 installs from a setup program, and it doesn't seem to matter whether you're installing over DOS, Windows, or an earlier W95. In each case, you get a warning that you're running QEMM, and you should disable it until the installation is finished, or else W95 may not identify all your hardware correctly. I suspect that mostly means that QEMM loads some device drivers into high memory and W95 isn't sure it will find them all; in any event, I have ignored that message in the past with no ill effects.

This last time, though, I decided to heed the message. I canceled the installation, removed all references to QEMM from my CONFIG.SYS and AUTOEXEC.BAT files, and put in DOS HIMEM.SYS and EMM386.EXE. Then, just for good measure, I exited W95 with the option to boot up in DOS and ran the DOS MEMMAKER.EXE program, answering "yes" to the question about running programs that need expanded memory.

The result wasn't good. Not only did I end up with DOS windows that were about 100 KB smaller—far too small to run most games—but my expanded memory had vanished as well. I rebooted. That automatically brings the machine back up in W95. When I ran the setup program again to finish my upgrade, I was told that I'd interrupted it last time and was warned there might be trouble; but there wasn't any difficulty, except that I got messages that EMM386 couldn't load, and my DOS windows remained tiny. I put up with that for about 5 minutes before I overwrote the CONFIG.SYS and AUTOEXEC.BAT files with my older versions containing QEMM. When I rebooted and let QEMM do its thing, I had no problems. My DOS

windows are 590 KB, and expanded memory works again.

I've been using Franklin Quest's Ascend PIM (personal information manager) for several years now. Telemagic is a far better contact manager, but it's designed for a much larger operation than mine. While there are many good things about Arabesque's Ecco, Ascend is good enough.

I've just installed version 5.0, and the upgrade illuminates a problem with W95 communications.

Despite the improvements in Procomm Plus for Windows, I unrepentantly use Procomm 2. I'm used to it. It runs on my Gateway HandBook (a 286) and does fine in a DOS window; but it has quirks. After I switched to W95, I had an annoying glitch. At first, Procomm couldn't find the modem. When I hit Escape and dialed again, lo!, all was well.

Naturally I blamed that on W95. Then I found that Ascend 4.0 worked just fine in Windows 3.11 and W95, but version 5.0 wouldn't dial in W95. Instead, I got a Windows message that some other device had the COM port. Franklin Quest had no advice—surprisingly, they have never tested Ascend with W95—but they told me that Ascend 4.0 had its own dialer, while version 5.0 uses the Microsoft Dialer built into Windows.

You access the controls for the Microsoft Dialer through the Telephony button on the control panel. For reasons having to do with cable connections, I've used COM1 for the mouse and COM2 for the modem since DOS days. I had no problems with SideKick, Desqview, or any version of Windows; but with W95, no matter that I told Telephony to use COM2, Ascend 5.0 would report that the communications device was in use by another program. Finally, in exasperation, I shut down the machine, plugged the mouse into COM2, and connected the modem to COM1. Then I told both Procomm 2 and Telephony what I'd done. That fixed it. Ascend 5.0 dials just fine now.

Now I have discovered that if you give Procomm 2 an initialization string, it must have Control-M at the end, else it waits for a Return. I lost the Control-M while installing W95 (my fault I'm sure); it was never a problem with W95 itself. My apologies to Microsoft: they've been trying to fix that bug since I reported it.

Although that fixed the problem—Ascend 5.0 dials just fine now—alas, it has *not* fixed the "must access it twice" problem with Procomm 2, which remains as an annoyance. So it goes.

OS/2 Warp Connect is nifty, and it really is an improvement over standard Warp. In theory, it's still only Warp 3.0 with connectivity; in practice, they've incorporated some bug fixes and made installation simpler by adding more device drivers.

OS/2 is still harder to install than it ought to be. Every time I say that, I get letters from readers who bought one or another flavor of Warp and had absolutely no problems with the installation, and others who think it was easier to install than Windows ever was, so your mileage may vary. Once installed, OS/2 Warp Connect is pretty solid. Unlike W95, which still contains some 16-bit code, OS/2 is all 32-bit. With only a few windows open, there's little difference in speed between OS/2 Warp Connect and the test versions of W95; but if you keep a lot of windows open and do a lot of multitasking, the difference can be dramatic.

Using the IBM Pentium ValuePoint,

I've managed to get three simultaneous communications programs—two using 9600-bps modems, and one using a serial port—as well as a print job to run in OS/2. The printing was pretty slow, but the communications tasks worked without losing data. I haven't tried that with W95, but I don't need to. Just keeping a number of windows open (and doing nothing) will noticeably slow down W95.

The big new feature of OS/2 Warp Connect is built-in peer-to-peer networking capability. OS/2 Warp Connect supports IBM LAN Server 2, 3, and 4, and the LAN Server on AIX and AS/400. You can connect to Windows for Workgroups, Windows NT Server, W95, and the Microsoft LAN Manager, as well as all versions of Novell NetWare. The feature set is comparable to W4WG, with cut and paste across the network. I mildly prefer the W95 user interface, but the Warp interface is good enough.

OS/2 Warp Connect works just fine, with one exception. In Windows and W95, if you do Ctrl-Alt-Del, you get a dialog box that gets you back to the OS, where you can choose to shut down individual applications or the entire system. Warp doesn't do that. If you press Ctrl-Alt-Del, the system will reboot without further ceremony. Alas, that means that if you run a particularly badly behaved application, you may find yourself unable to get back to OS/2. That happens more often with bad Windows applications in Warp, but I've had it happen with a DOS program as well, and it's a terribly frustrating experience.

One reason Microsoft held its latest dog and pony show was to impress journalists with just how many software developers are writing applications for W95; it worked. About a hundred companies, hardware and software, had booths in a miniature trade show. The booths were small, not flashy, and the emphasis was on technical demonstrations. It reminded me of the early days of the West Coast Computer Faire.

Naturally, the Microsoft Applications Group was showing the most products, including new versions of Microsoft Office; but there were many others. Traveling Software was there with new versions of LapLink for Windows. You'll really like what they can do with W95. Philippe Kahn, still chairman of Borland but no longer running that company, was there demonstrating Starfish Software's Side-Kick for Windows.

Symantec was there, with a new version of Norton Utilities for W95. I use that, and I'd hate to live without it. They also have a new Norton Navigator (a desktop replacement) for W95. I've got it, but I don't really feel the need; I rather like the W95 interface. But if you get W95, be *sure* to get the appropriate Norton Utilities.

You'll also need the *Windows 95 Resource Kit* from Microsoft Press. It has over 1300 pages and goes into great detail on stuff you'll want to know. There's a good section on using long filenames and what happens if you transfer those files to systems that don't support long filenames. Reading that will lead you to look into long file extensions—you're no longer limited to three characters after the dot—and how those can be used to tell W95 things about a file. That will lead you to read the section on the Registry, a W95 trick to cut down on the sizes of INI files.

continued

URGENT—YOUR INPUT NEEDED

Platform Issues in Applications Development

Dear Reader:

To improve BYTE's coverage of technology in the State of the Art section, we'd like to get your feedback about what specific topics, areas, and products we should be considering, and in what ways. Specifically, we're planning later this year to take a look at the development of software for new (as well as for multiple) platforms. We want to explore the issues involved in developing applications to run on brand new OSes or those in a state of flux (as with Windows 95 in its beta days); at cross-platform development tools, problems, and capabilities; and at what the advent of (at least partially) object-oriented OSes means for applications developers.

These are complex questions and to do them justice we'd like to hear your views—what you're interested in, what you'd like to see us report on and analyze. We want to hear your ideas and find out about concerns that we may not fully appreciate or be aware of. Also, we'd like your help in knowing who are the people we should be talking to—users, vendors, researchers—you tell us.

To let us know what you think, please use the following as a template to send us, via E-mail, an ASCII text file with your comments. Please be sure to include the <FIELDNAMES> with their angle brackets, followed by your information and comments. And thanks very much for your help.

Please E-mail the completed form to: **surveys@bix.com**

<TOPIC>
App Development for Platforms

<LASTNAME>
Ziegler

<FIRSTNAME>
Teddy

<TITLE>
Sr. Software Engineer

<COMPANY>
Universal Applications Unlimited

<PHONE>
800-555-4321

<EMAIL>
tz@host.domain

<COMMENTS>
This is where your comments go. Be as brief or as long as you want. Tell us what you think, what you need, what you want to know more about. Tell us what you're doing. Tell us who we should be talking to.

Hit the Road...

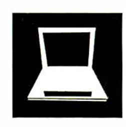
without ever leaving the information superhighway.

WIN a 1996 Mitsubishi Galant LS

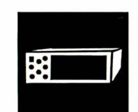
Win a luxurious 1996 Mitsubishi Galant LS including leather seating surfaces, power driver's seat, and the exclusive Mitsubishi HomeLink™ system. Plus you get all the other tools and toys you need on the road:*

*Exclusive among imported midsize sedans.





Tadpole P1000 Notebook: Take all your power apps on the road with this super-fast 100 MHz Pentium notebook from Tadpole Technologies.



Mobile Assistant: Wireless communications and route guidance system for the mobile office from Solid Computer Group.



CompuServe: The world's premier online service with full Internet access. One-year subscription includes $250 monthly usage credit.*

*Unused usage credit may not be applied to subsequent months.



Cellular Phone: Compact, easy-to-use, flip-style, state-of-the-art cellular phone for the car, the sidewalk, the boardwalk, the boardroom, etc.

PUT YOUR PEDAL TO THE METAL!

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Winner to be announced at the BYTE booth #2654 at COMDEX/Fall.

NAME: ____________________

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Fax your entry to 603-924-2535 or mail to:
BYTE, One Phoenix Mill Lane, Peterborough, NH 03458

SWEEPSTAKES RULES

The contest is open only to U.S. residents who are licensed drivers, 18 years of age or older. No purchase necessary. Entrants should fill out their daytime telephone number as indicated on the official entry form. You may obtain an entry form by sending a self-addressed envelope to BYTE Mobile Office of the '90s Sweepstakes, One Phoenix Mill Lane, Peterborough, NH 03458 by November 15, 1995 or fax to (603) 924-2535. Limit: one entry per person.

Entries must be received by mail or fax on or before November 15, 1995, or submitted in person at BYTE's Booth at Comdex/Fall, Las Vegas, from November 13 to November 15. The finalist will be determined in a random drawing to take place at BYTE's Comdex Booth #2654 at 3:00 PM on November 16, 1995. The winner will be contacted by telephone following the drawing and announced in the January 1996 issue of BYTE. Personal contact with the individual specified on the entry card must be made for the finalist to be declared the winner. If the winner cannot be contacted within 15 days of the drawing, then the unclaimed prize will be awarded to an alternate winner selected at random.

The winner shall be required to sign an affidavit of eligibility and a liability/publicity release which releases McGraw-Hill, Inc., from liability in connection with the winner's use of the prize, and permitting McGraw-Hill to use the winner's name and likeness to promote the contest where permitted by law.

The odds of winning depend on the total number of entries. McGraw-Hill, Inc., Mitsubishi Motors, and their respective advertising agencies, subsidiaries, employees and employees' families are not eligible to participate in this contest. McGraw-Hill, Inc. is not responsible for lost, late, or misdirected mail or ineligible entries. All Federal, State and/or local rules and regulations apply. Void where prohibited by law.

One prize to be awarded: a 1996 Mitsubishi Galant LS (approximate value: $23,088), plus various mobile computing tools described above; total prize value: $36,052. Vehicle specifications, including color, will be determined by Mitsubishi Motors. Standard manufacturer's vehicle warranty will be provided. Vehicle will be delivered to Mitsubishi dealer closest to winner's locale. Winner is responsible for registering, licensing, and insuring the vehicle. The prize is not redeemable for cash, nor is substitution of the prize by the winner allowed. The winner is responsible for any and all taxes associated with the acceptance of the prize. BYTE reserves the right to substitute a comparable prize upon unavailability. For the name of the winner, send a self-addressed, stamped envelope after November 16, 1995 to Marketing Dept., Mobile Office of the '90s Winners, BYTE Magazine, One Phoenix Mill Lane, Peterborough, NH 03458.

Bottom-line question for Windows users: Should you change OSes? In my judgment, yes you should. W95, Windows NT, and OS/2 Warp Connect are all significant improvements over Windows and W4WG. You'll be better off with one of those.

Deciding which one isn't so easy. If you're operating in a large corporate environment, you should probably be considering Windows NT versus OS/2 Warp Connect plus OS/2 LAN Server. You'll certainly want to consider Lotus Notes, and now that IBM is buying Lotus, you'll want to watch developments there.

For home users, the choice is a bit simpler. The less you like fooling around with your machine, the more you're going to appreciate W95. You're far more likely to have a painless upgrade going from Windows to W95 than you will when switching to Warp.

One big attraction of OS/2 has been that it is a better DOS than Windows and, for that matter, a better DOS than DOS. That remains true, but it's not a better DOS than W95—and it's certainly not a better Windows than W95. The more you run Windows (not W95, just Windows) applications, the more you'll appreciate W95. And, of course, we don't even know what IBM plans for handling applications written for W95 itself. We do know there will be far more applications written for W95 than for OS/2.

I'm keeping both. We'll continue to run OS/2 Warp Connect, but I have to say my prime machine is already running W95. That could change. Stay tuned.

It's silly, but I'm still taking two laptops on trips. The Gateway Liberty 2000 remains my favorite for working on airplanes and in meetings, but the Zenith Z-Noteflex gets set up in my hotel room and is used for heavy-duty work there.

Part of that is Zenith's reliability. The Gateway Liberty is reliable enough, but the catch that holds the battery is next to the one that secures the removable hard drive, and I have now twice managed to unlatch that drive. The result is that the drive comes slightly loose, and you have to reboot. I've never lost any data this way, but it worries me. Of course, I can fix the problem forever with duct tape. I'm not really worried about the Liberty.

The other part is the keyboard. The Z-Noteflex's keyboard is just better for typing when I'm trying to bang out text. It's not that the Liberty's keyboard is bad, just that the other one is better. And the Z-Noteflex has a built-in floppy drive, while the Liberty's floppy drive is an external attachment. This makes the Z-Noteflex heavy enough that I don't really want to put it into a briefcase.

The upshot is that I've got one of those wheeled carry-on flight bags, and when I stuff it with two computers, their power supplies, a couple of manuals, and my Ascend notebook, the thing is heavy enough to leave ruts in the tarmac. But I've never had any problem stuffing it into an overhead rack, and I need the exercise.

The Z-Noteflex has a Data Race Redi-Card RC-1496 data/fax modem. It works fine at 9600 bps. But it needs a special cable that plugs into the PCMCIA card on one end and connects to a phone line on the other; more than once when I've been online, something jarred the cable connector enough to make the system hang up.

By contrast, the Liberty has a Megahertz 14.4-Kbps PCMCIA data/fax modem with XJack. That also works just fine at 9600 bps, and the XJack connector lets you plug a normal phone cord into it. I've never had that shake loose. I've tested both modems for months now, and while I have no preference on performance, the XJack's convenience is a deciding factor. I recommend the Megahertz PCMCIA data/fax modem card.

It's easy to forget that the first A in NASA stands for aeronautics; but in fact NASA Ames does some great work. One such is a software simulation of a Boeing 737. As its developer Steve Casner put it, there's something uncanny about carrying around the brains of a big modern airplane under your arm. The simulation runs on a Mac PowerBook. If you're interested in finding out more, you can E-mail him at casner@eos.arc.-nasa.gov, or write to Stephen Casner, NASA Ames, Mail Stop 262-4, Moffett Field, CA 94035.

The book of the month is *Crime,* edited by James Q. Wilson and Joan Petersilia (ICS Press, 1995). This will tell you more than you want to know about crime in this country. Essays are presented from nearly every rational point of view. It's not fun reading, but perhaps it's time citizens gave some heavy thought to the problem.

Two computer books of the month. The first one is Jeannette Lawrence's *Introduction to Neural Networks* (California Scientific Software, 1993). This isn't easy reading, but no book on neural networks is; but it is comprehensible when it talks about back propagation and the like. Neural networks are becoming increasingly important as computers get more powerful.

The second computer book of the month is by Ronny Richardson, *The Ultimate Batch File Book* (Tab/McGraw-Hill, 1995). It certainly lives up to its title. There are batch files for MS-DOS, PC-DOS, Novell DOS 7, OS/2 Warp, and Windows; and it comes with a CD-ROM of batch and help files. Studying well-written applications is the best way I know of to learn how to write them.

Next month: more on connectivity, and a whole mess of small applications. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.

Product Information

In **Ascend 5.0** ($149.95), some changes are for the better, and I expect overall it's a genuine improvement. Contact **Franklin Quest Co.**, Salt Lake City, UT, (800) 877-1814 or (801) 975-9992; on CompuServe, go franklin. **Circle 1274 on Inquiry Card.**

The **Digital Frog** (US$170) is an excellent example of what new technology and ingenuity can do for education. Contact **Digital Frog International**, Puslinch, Ontario, Canada, (519) 766-1097; dfi@sentex.net. **Circle 1275.**

The **Interactive Multimedia Self-Study Modules** (per module, US$299) for veterinary medicine impressed me a lot. Contact **Lifelearn V., Inc.**, Guelph, Ontario, Canada, (800) 375-7994 or (519) 767-5043; rnigol@ovcnet.uoguelph.ca. **Circle 1276.**

The big new feature of **OS/2 Warp Connect** (fullpack edition with Win-OS/2 code, $299) is built-in peer-to-peer networking capability. **IBM Corp.**, Austin, TX, (800) 342-6672 or call your local IBM dealer; http://www.ibm.com. **Circle 1277.**

The **PCMCIA data/fax modem with XJack** ($249) works just fine at 9600 bps, and the XJack connector lets you plug a normal phone cord into it. Contact **Megahertz Corp.**, Salt Lake City, UT (800) 527-8677 or (801) 320-7000; http://www.xmission.com/~mhz. **Circle 1278.**

PREVIEW | PC NOTEBOOKS

Impressive Battery Life in a Laptop Pentium PC

Dell's Latitude line of laptops has been a remarkable resurgence for a company so thoroughly out of the laptop business a few years ago. The new Latitude XPi combines 75- and 90-MHz Pentium power with Dell's renowned battery life. We tested the XPi P90T, which uses Intel's new low-voltage 90-MHz Pentium. The P90T has an active-matrix TFT screen, and our test unit came with 16 MB of RAM and an 810-MB hard drive.

The XPi P90T is smart and aggressive about stretching its battery life—so much so that it confounded our Thumper 2 battery tester. On a recent trip from Manchester, New Hampshire, to San Francisco, we used the XPi for at least 3 hours' worth of editing, and there was battery life to spare when we arrived in California.

The low-voltage Pentium is designed specifically for mobile applications and runs at 3.3 V externally but at just 2.9 V internally. As a result, it runs cooler than previous 90-MHz Pentiums and consumes less power. Combined with high-power lithium-ion batteries, this gives the P90T remarkable battery life. These low-voltage Pentiums will soon show up in everyone's laptops, but Dell's Latitude XPi P90T is one of the first to have them.

The XPi is not perfect. It lacks some features that we've come to expect in high-end laptops, such as built-in sound support. And it was disappointing that the screen supports only 640- by 480-pixel resolution. But for people who need to do serious work during long plane rides, the XPi is just about perfect. —**Rex Baldazo**

Latitude XPi P90T
(90-MHz Pentium, active-matrix TFT screen)
As tested, with 16 MB of RAM and an 810-MB hard drive, $5398; base configuration, with 8 MB of RAM and a 340-MB hard drive, $4699.

Dell Computer
Austin, TX
(800) 289-3355
(512) 338-4400
http://www.dell.com/
Circle 976 on Inquiry Card.

Performance

Integer index	.99
Floating-Point index	1.12
(A 90-MHz Dell Pentium = 1)	

A SPARCSTATION 5 COMPATIBLE

The PowerLite 110 integrates a 110-MHz MicroSparc II microprocessor, up to 2.4 GB of internal hard disk storage, TGX graphics acceleration, an internal floppy drive, a fax modem, and a 10.4-inch, 1024- by 768-pixel, flat-panel color display, all in a compact 8½-pound package (from $12,995). Configurable options include four memory configurations (32, 64, 96, and 128 MB); your choice of two displays, the flat-panel color display or a Colorplus 640- by 480-pixel active-matrix LCD; and storage configurations from 810 MB to 6.4 GB, with an optional PowerLite Peripheral Expansion Unit. Other features include a 10Base-T AUI for Ethernet connection, a 10-MBps SCSI-2 port, two RS-232 ports, a Centronics port, an 8-bit audio connection (with internal speaker and microphone), a connector for an external monitor, and SBus expansion slots for use with the optional PXU.
Contact: RDI Computer, Carlsbad, CA, (800) 734-5483 or (619) 929-0992; http://www.rdi.com.
Circle 980 on Inquiry Card.

MULTIPROTOCOL NETWORK CD-ROM SERVER

Now users running Windows for Workgroups, Windows 95, or Windows NT, as well as those in an OS/2 or Unix environment, can simultaneously share networked CD-ROM information. The Axis 851/951 Network CD-ROM Server supports Ethernet and Token Ring, respectively, and lets you attach up to six external CD-ROM drives or jukeboxes in a series. With a built-in Etrax RISC processor and file cache, the 851/951 Network CD-ROM Server (Axis 851 for Ethernet, $899; Axis 951 for Token Ring, $1099) can achieve throughputs of up to 600 KBps.
Contact: Axis Communications, Woburn, MA, (800) 444-2947 or (617) 938-1188; http://www.axis.se/.
Circle 983 on Inquiry Card.

2-GB MINICARTRIDGE DRIVE

The Panther Mini 2000, a 3½-inch SCSI-2 tape drive, comes with a 2-GB Sony QIC-Wide data cartridge, Arcada Backup for DOS/Windows software with data compression, and cables. Available in internal and external configurations ($549 and $659, respectively), the Panther Mini 2000 drive automatically formats the data cartridge and verifies data as it records. You can back up 36 MB of data per minute, or approximately 1 GB in 55 minutes. The Panther Mini 2000 also features automatic load and eject and a protective door that closes behind the cartridge.
Contact: Tandberg Data, Simi Valley, CA, (800) 826-3237 or (805) 579-1000.
Circle 982 on Inquiry Card.

POWER MANAGEMENT FOR PRINTERS

Nightware ($109.95) turns off your printer during periods of inactivity and automatically restores power to it when needed. When Nightware restores power to the printer upon receipt of data, its momentary poll-and-store feature prevents an application time-out while the printer warms up. When the printer is ready, Nightware reconnects it to the host to resume printing.
Contact: Micro Energetics, Fairfax Station, VA, (800) 948-2099 or (703) 250-3000.
Circle 979 on Inquiry Card.

15-HOUR ZINC-AIR BATTERY ▼

The AER Energy PowerPro ($399) can power Toshiba Satellite T1900 series systems, Satellite Pro T2400 series systems, and T4700C, T4800CT, and T4850CT portable computers for up to 15 continuous hours between charges. The PowerPro battery fits under your computer, attaching via the battery socket. The Toshiba AC adapter recharges the PowerPro. When you attach the battery to your PC, you still have access to all your computer's drives and ports.



Contact: AER Energy Resources, Smyrna, GA, (800) 769-3720 or (404) 433-2127; 75321,3445@compuserve.com.
Circle 981 on Inquiry Card.



PENTIUM MULTIMEDIA SYSTEM ▲

The Multimedia Quadstation series of multimedia systems feature Lasonic surround-sound amplified speakers, Sound Blaster 16 cards, and Teac quad-speed CD-ROM drives. Each system (486DX2-66, $1578; Pentium/100, $2148; 486DX4-100, $1698; Pentium/90, $1998) ships with an 850-MB hard drive, 8 MB of RAM, a 256-KB cache, a 1.44-MB floppy drive, a PCI enhanced-IDE controller, and a 2-MB PCI local-bus graphics card with an ATI Windows accelerator. All systems also include a Sceptre 15-inch flat-screen noninterlaced digital-control SVGA monitor with 0.28-dpi, 1280- by 1024-pixel resolution.

Contact: Intellicomp Technologies, El Monte, CA, (800) 468-3696 or (818) 582-8096.

Circle 995 on Inquiry Card.

SPARC 5–COMPATIBLE WORKSTATION

Incorporating a 110-MHz MicroSparc II processor, the SWS5/110 comes with five 32-bit master/slave SBus slots capable of supporting double- or triple-width SBus cards, a 64-bit AFX graphics bus, up to 256 MB of internal RAM, and 100 percent binary compatibility with the Sun SparcStation 5. The SWS5/110's storage options include an internal 644-MB double-speed Photo CD–ready CD-ROM, two internal hard drives, and one internal 3½-inch 1.44-MB floppy drive. A base-configured workstation with system board, chassis, keyboard, mouse, and power supply costs $3495; a complete system with a 110-MHz MicroSparc II CPU, 32 MB of memory, a 1-GB hard drive, a Turbo GX graphics card, and a 17-inch color monitor costs $7495.

Contact: Integrix, Newbury Park, CA, (800) 300-8288 or (805) 375-1055; http://www.integrix.com.

Circle 984 on Inquiry Card.

ERASING ULTRAPEN

The Erasing UltraPen lets you erase as you would with a real eraser—the harder you press, the more it erases—and offers up to 256 levels of pressure. For software that's not eraser-aware, the $89.99 device allows you to select and delete text or cells with one stroke. Also available are the WideBody UltraPen With Pencil ($125) and the DuoSwitch UltraPen ($125), which meets multiple-mouse-button standards in Windows and Unix OSes.

Wacom's latest graphics tablets include the ArtPad II with Erasing UltraPen ($174.99), ArtZ II 6 × 8 with Erasing UltraPen ($389.99), ArtZ II 12 × 12 with Erasing UltraPen ($539.99), ArtZ II 12 × 18 with Erasing UltraPen ($869.99), and ArtZ II 18 × 25 with Erasing UltraPen ($2449.99).

Contact: Wacom Technology, Vancouver, WA, (800) 922-6613 or (360) 750-8882.

Circle 992 on Inquiry Card.

INTEGRATED AUDIO/ TELEPHONY PRODUCT

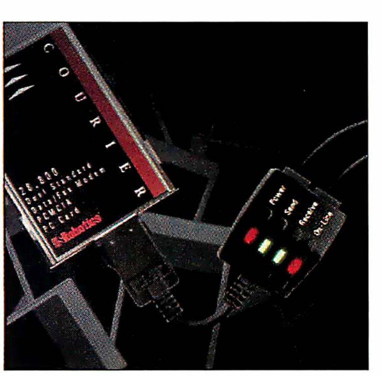
Featuring audio, fax, and modem functions, the TeleCommander 2500XL ($229) integrates a 16-bit CD-quality sound card that works with Sound Blaster Pro–compatible applications and a 14.4-Kbps Rockwell modem (V.32bis) and 14.4-Kbps fax (V.17). The all-in-one desktop-communications solution also includes call screening, call forwarding, and remote-message access, as well as fax-forwarding, fax-on-demand, and pager-notification capabilities. The package comes with Thought Communications' FaxTalk Messenger and FaxTalk Speakerphone; Radish Communications' Voice View technology, which lets you send and receive files during a single telephone conversation without hanging up; and on-line-services software for America Online, CompuServe, Imagination Network, and Internet access.

Contact: Diamond Multimedia Systems, San Jose, CA, (800) 468-5846 or (408) 325-7000; http://www.diamondmm.com.

Circle 991 on Inquiry Card.

PCMCIA MODEM WITH STATUS LIGHTS ▼

U.S. Robotics' Courier V.Everything PCMCIA PC Card with DataView ($575) has four LEDs that let you monitor power, send, receive, and on-line functions during a fax or data transfer. The card provides connectivity to industry-standard V.34 modems;

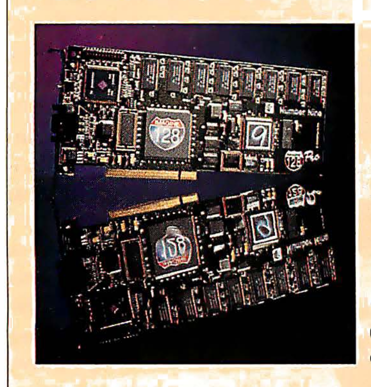


backward compatibility with proprietary standards, such as V.FastClass and V.32 terbo; and compatibility with V.32bis and slower-speed modems. Other features include flash ROM upgradability, remote configuration, link security, dial security, and Easy Install software. Also available is a 14.4-Kbps version of the device, the Courier V.32-bis PCMCIA PC Card with DataView ($499).

Contact: U.S. Robotics, Skokie, IL, (800) 877-2677 or (708) 982-5010.

Circle 990 on Inquiry Card.

PLUG-AND-PLAY MPEG CARD

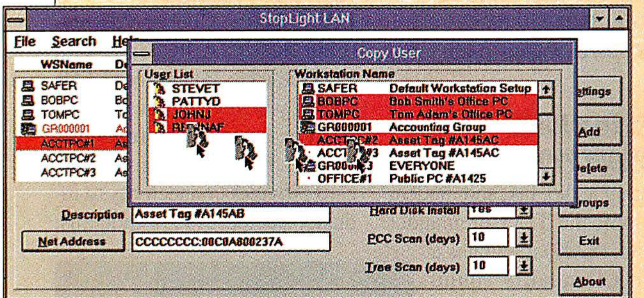


The 9FX-PlusMPEG card ($199) for PCI-based PCs lets you load and view MPEG video files without having to change your Windows settings. In addition to high-quality video, the card feeds synchronized 16-bit CD-quality audio through a mini-jack, which you can connect to stereo speakers or another external amplifier or back into your PC's 16-bit sound card for sound-mixing. To take advantage of the 9FX-Plus-MPEG card, your system needs a PCI graphics accelerator with DCI support.

Contact: Number Nine Visual Technology, Lexington, MA, (800) 438-6463 or (617) 674-0009; on CompuServe, go nine.

Circle 977 on Inquiry Card.

MAINFRAME-CLASS SECURITY FOR PCs AND LANs



StopLight 95 (single copy, $295) prevents unauthorized PC access, illegal and unwanted file copying, configuration changes, and other security problems on individual and networked Windows PCs. The LAN version lets you control and automate security from a central workstation. You can restrict access to individual drives, partitions, directories, and individual files; specify kinds of access, such as read, write, create, and delete, for each of these levels; and prevent users from copying program executables to or from machines. The program also includes the Drive-In AntiVirus utility, which scans and disinfects hard and floppy drives and network volumes for boot-track viruses before they can cause harm.

Three versions are available: StopLight 95/LAN, client and server security software for centralized control of all LAN workstations; StopLight 95/PC, which offers full security features for a single PC, with the ability to define profiles for up to 255 users; and StopLight 95/ELS, an entry-level security package without antivirus capabilities that supports two user profiles.

Contact: Security Integration, Lexington, MA, (800) 888-5031 or (617) 861-8800.

Circle 996 on Inquiry Card.

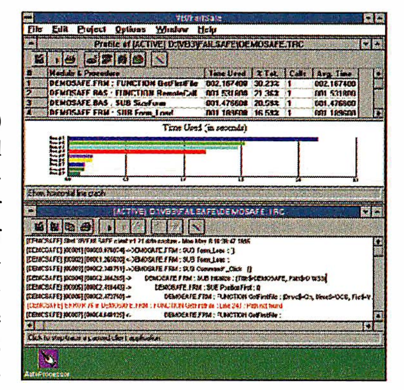
32-BIT IMAGING SOFTWARE

A high-level C library with optimized commands for image processing, pattern matching, blob analysis, gauging, and OCR (with an optional module), MIL-32 is a 32-bit version of the Matrox Imaging Library that allows you to build applications using only a few lines of code. The library (US$1495) supports Windows NT, 32-bit DOS extenders, and Win32s and runs on VGA imaging boards.

Contact: Matrox Electronic Systems, Dorval, Quebec, Canada, (800) 361-4903 or (514) 685-2630; imaginginfo @matrox.com.

Circle 998 on Inquiry Card.

DEBUG, ANALYZE VISUAL BASIC APPLICATIONS ►



The VB/FailSafe ($179.95) integrated debugging and performance-analysis system for Visual Basic for Windows integrates error interception, program tracing, and performance profiling into a single software tool. The package includes FS/Interceptor, which stabilizes a project and stops system crashes by intercepting and coding all errors by type, class, number, and description; FS/Tracer, which aids in isolating event-driven and client/server bugs, as well as bugs lurking within compiled executable programs that Visual Basic's built-in step-trace is unable to find; and FS/Profiler, which uses information from FS/Tracer to produce graphs and tables showing program performance, routine by routine.

Contact: Marquis Computing, Pomfret Center, CT, (800) 818-1611 or (203) 963-7065; 76120.2413@compuserve.com.

Circle 1000 on Inquiry Card.

INTERNET CLIENT/SERVER SOFTWARE

Operating in the Windows environment, MindWire 1.0 (eight-user license, $495) helps you to create a dynamic multimedia on-line service offering modem, network, and Internet connectivity options. The MindWire Client software contains messaging, file-library, E-mail, and chat features. MindWire provides support for image and sound files, spell checking for E-mail, viewing user photos, auto-viewing downloaded files, and scanning message responses. MindWire performs multiple functions simultaneously, including downloading and uploading files, chatting with other users, and reading E-mail.

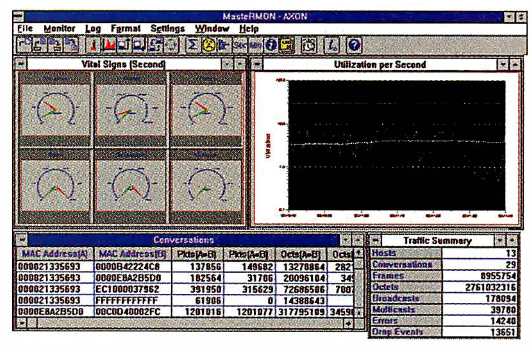
The MindWire Server lets you manage and configure application features such as account information, security, file-library folders, and messaging forums. MindWire controls user privileges and security. An audit trail records user transactions on the Server and generates reports to monitor your system's activity. The Client Application Manager performs automatic on-line software updates and installation of new applications.

Contact: Durand Communications Network, Santa Barbara, CA, (805) 961-8700; http://www.durand.com.

Circle 1011 on Inquiry Card.

DISTRIBUTED NETWORK-MONITORING SOFTWARE ▼

MasteRMON 1.0 displays the activity of a selected Ethernet or Token Ring LAN segment via RMON agents. The program transparently handles SNMP functions and takes advantage of Windows' multitasking capabilities by letting you execute several concurrent instances of MasteRMON on the same machine. MasteRMON (single license, $595) displays traffic from all stations, or nodes, present on the monitored segment; offers several real-time display modes; provides user-configurable alarms; includes a baselining feature that automatically learns the normal traffic levels of the network and configures MasteRMON accordingly; generates snapshot reports of network activity at configurable time intervals; and offers real-time graphing capabilities.



Contact: Triticom, Eden Prairie, MN, (612) 937-0772; http://www.triticom.com.

Circle 1003 on Inquiry Card.



LANTASTIC POWER SUITE ▲

An integrated product, LANtastic Power Suite (one-user software-only kit, from $199) contains the LANtastic network OS and communications software. In addition to LANtastic, the suite includes Lotus cc:Mail communications software, the Lotus Organizer networked group scheduler and PIM, Cheyenne Communications' BitWare fax and modem communications software and BitShare modem-sharing and pooling software, and Netcom NetCruiser Internet-access software.

Contact: Artisoft, Tucson, AZ, (800) 233-5564 or (602) 670-7100; http://www.artisoft.com.

Circle 1013 on Inquiry Card.

EXCHANGE BINARY FILES VIA FAX ▼

With 3D Fax, you can send and receive editable or executable files via standard fax. In addition, 3D Fax includes compression and image-processing features that allow you to reduce fax-transmission time by at least 90 percent. You can also send color pictures and multimedia files. When you send a file to a fax machine, it's visually uninterpretable. You scan the printed image into a computer, and the 3D Fax software (standard version, $99; professional version, $199) restores the file to its original content and format and opens it in the software application in which you created it.

Contact: InfoImaging Technologies, Palo Alto, CA, (800) 966-1140 or (415) 960-0100; http://www.infoimaging.com.

Circle 1012 on Inquiry Card.

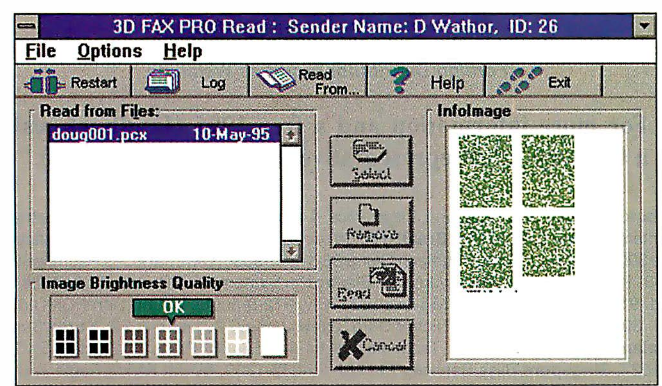


IMAGE EDITING FOR THE MASSES

Image'n'Bits 2.0 ($79) can convert images, regardless of their origin, to OLE objects ready for you to edit, tile, and drag and drop into other applications or convert to other file formats. The program allows you to embed or link an image file into another application for editing without having to exit that application. You can also tile and convert to thumbnails objects stored inside the Image'n'Bits albums. Image-processing functions include flip, mirror, convert to negative, false color substitution, smooth, blur, sharpen, posterize, edge detection, pixelize, and emboss. Distortion filters include pinch, spiral, fish-eye, paint, star, melt, and wavy.

Contact: Bananas Software, Paramus, NJ, (800) 653-4624 or (201) 265-9855; banana@ios.com.

Circle 1008 on Inquiry Card.

METERING SOFTWARE FOR NETWARE LANS

LANrecord 1.0 provides metering and chargeback for software applications, suite-based products, files, and other LAN resources, such as network connections. The program helps you comply with software application licenses and provides LAN administrators with data about the computing costs incurred by users and departments. An export feature lets you export chargeback information to external applications. LANrecord 1.0 (base server, $595; additional server licenses, $395) maintains in its database information that's gathered during the metering process and offers real-time-dynamic and history-reporting features.

Contact: Horizons Technology, San Diego, CA, (800) 828-3808 or (619) 292-8331; http://www.horizons.com.

Circle 997 on Inquiry Card.

KEEP YOUR VISUAL BASIC CODE IN ORDER

The Polisher ($149) formats, comments, and spell-checks your Visual Basic programs. You can automatically generate a comment block at the start of every routine and insert comment blocks at the start of modules and procedures, with variables such as developer name, company, and date. The Polisher lets you remove or insert blank lines before or after block constructs throughout the code and allows you to specify the number of spaces to auto-indent and the indent options for declarations, Select Case, and IF...THEN...ELSE formatting.

Contact: Aardvark Software, Teaneck, NJ, (201) 833-4355; 70544.1372@compuserve.com.

Circle 1015 on Inquiry Card.

Software Update

The **Track 3.0 for Windows** LAN-based defect-tracking and technical-support system adds the following: integration with version-control systems, which lets you keep track of the changes you make to source, design, and documentation files; enhanced reporting and analyzing features, which let you link Track's database with multiple external databases, link a defect database to a customer or project database, and import test results generated by automated testing tools; and support for Microsoft Mail and cc:Mail. $495.

Contact: Soffront Software, Milpitas, CA, (408) 263-2703; info@soffront.com.

Circle 1024 on Inquiry Card.

Hi-Res 5.0, an SDK for Windows that provides for fractal still-image compression and decompression, offers compression ratios from 3-to-1 to 250-to-1; faster decompression rates; smaller file sizes for compressed images, which lets you place more images on a CD-ROM or other storage medium; improved resolution independence, allowing an almost unlimited number of zooming levels; color mapping; and cross-platform support for Windows 3.1, Windows 95, Windows NT, Macs, and the PowerPC. The package is available in two versions: Hi-Res Professional 32 ($8995) and Hi-Res Standard 32 ($2995).

Contact: Iterated Systems, Norcross, GA, (404) 840-0310; 73443,1674@compuserve.com.

Circle 1023 on Inquiry Card.

RightFax for Windows NT is 32-bit multitasking and multithreaded LAN fax-server software that allows workstations on a Windows NT network to send and receive faxes. Server license for a single channel with unlimited users, $1995.

Contact: RightFax, Tucson, AZ, (602) 327-1357.

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Ascentia 950N 5/75 800MB act color	4719.13
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Advantage! 6066d 4/66 540MB CD	1019.62
Advantage! 8075p 5/75 1GB CD	1843.13
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360CE DX2/50 340MB act color	3099.00
360CE DX2/50 540MB act color	3449.00
701CS DX4/75 360MB act color	4299.00
701CS DX4/75 540MB act color	4599.00
701CS DX4/75 540MB pas color	3849.00
755CE DX4/100 540MB act color	5349.00
755CE DX4/100 810MB act color	5799.00
755CD DX4/100 540MB act color, CD	6349.00
755CD DX4/100 810MB act color, CD	6799.00
755CX 5/75 540MB act color	6549.00
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Aptiva

Aptiva 535 DX2/66 540MB	1349.00

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PC300 5/75 8MB, 540MB	1612.26
PC300 5/90 16MB, 850MB	2381.26
PC350 5/75 8MB, 540MB	1879.00
PC350 5/75 16MB, 850MB	2339.00
PC350 5/90 16MB, 850MB	2743.00
PC750 5/90 16MB, 540MB	2961.00
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NEC

Versa V DX2/50 250MB dual clr	2149.87
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Versa V DX2/50 340MB act clr	2389.81
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Versa 2000D 4/75 4MB, 350MB dual clr	1919.84
Versa 2000C 4/75 4MB, 350MB act clr	2257.17
Versa 2000C 4/75 8MB, 350MB act clr	2489.73
Versa 2000C 4/75 8MB, 540MB act clr	2678.82
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Versa M DX4/75 540MB hi-res clr	3337.46
Versa M DX4/100 540MB hi-res clr	3939.55
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TM4000M DX4/75 455MB dual color	2499.78
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BJC70 color	355.65
BJ100	175.86
BJ200ex	199.70
BJ230	391.55
BJC600e color	471.99
BJC4000 720dpi + color	348.78

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AP3250	146.45	DFX5000 Plus	1528.29
AP3260	167.82	DFX8000	2559.89
LX300	174.32	Stylus 300	183.16
FX870	303.95	Stylus 800+	215.47
FX1170	405.23	Stylus 1000	479.34
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LQ870	454.44	ActionLaser 1100	383.62
LQ1170	689.85	ActionLaser 1400	495.53

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WinWriter 400 laser	755.03
WinWriter 600 laser	999.00
ValueWriter 300 (4037 5E 5PPM)	644.87
ValueWriter 600 laser	815.87
4039 10 Plus 10ppm	1218.36
Optra R 12ppm	1423.63
Optra Rx 16ppm	1988.33
ExecJet IIc	293.76

Panasonic

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2023	182.27
2130	204.40
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KX-SP100 printer/fax/copier	776.54

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microLaser Pro 600 PS23	1197.02
microLaser Pro E	1395.49
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345MB SCSI-2	174.50
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Acculogic SIDE-4+ w/par. 2ser. game	35.06
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Adaptec AHA1542CF SCSI-2	265.45
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14.4K external w/fax	111.00
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Hayes

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OPTIMA 144 pocket w/fax	312.59
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MICROCOM

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Deskporte Fast ES V.34 28.8	179.94
Deskporte Fast EP V.34 28.8	239.99

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BackUPS 400	144.28
BackUPS 450	175.81
BackUPS 600	243.00
BackUPS 900	345.76
BackUPS 1250	449.29
SmartUPS 400	299.69
SmartUPS 600	363.38
SmartUPS 900	514.61
SmartUPS 1250	644.24
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BC PRO 550	188.16
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Intel OverDrive DX2/50	125.68
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••• PC Magazine, May 16, 1995

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••• Windows Sources Magazine, April 1995

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Processor	Screen	HD	Price
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Pentium 75MHz	10.4" Active	772MB	4359

400

90MHz Pentium

Portégé 610CT

Processor	Screen	HD	Price
Pentium 90MHz	9.5" True Color	720MB	$4359

Portégé 610CT



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Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	330MB	$1929
486DX4/75	10.4" Dual Scan	500MB	2459
486DX4/75	10.4" Active	500MB	3059

Additional Toshiba Notebooks

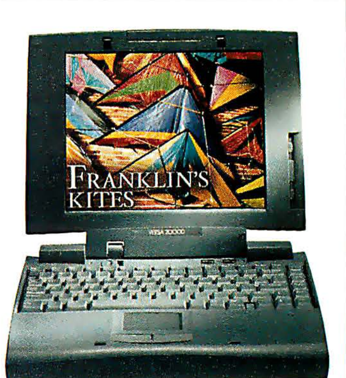


T4900

Processor	Screen	HD	Price
T4900CT			
Pentium 75	10.4" Active	772MB	$4799
Satellite T2100			
486DX2/50	9.5" Mono	250MB	$1239
486DX2/50	10.4" Dual Scan	330MB	1789
486DX2/50	8.4" Active	330MB	2399
Satellite T2150			
486DX4/75	10.4" Dual Scan	500MB	$2929
486DX4/75	10.4" Active	500MB	3699

NEC

Processor	Screen	HD	Price
Versa V			
486DX2/50	9.5" Dual Scan	250MB	$2129
486DX2/50	9.5" Dual Scan	340MB	2179
486DX2/50	9.5" Active	250MB	2269
486DX2/50	9.5" Active	340MB	2369
486DX2/50	9.5" Active	540MB	2649
486DX4/75	9.5" Active	340MB	2549
486DX4/75	9.5" Active	540MB	2739
486DX2/50	10.1" Active	340MB	2549
486DX4/75	10.1" Active	540MB	2929
Versa M			
486DX4/75	9.5" Dual Scan	340MB	$2459
486DX4/75	9.5" Active	340MB	2739
486DX4/75	9.5" Active	540MB	3029
486DX4/75	9.5" High Res.	540MB	3199
486DX4/100	9.5" Active	340MB	3399
486DX4/100	9.5" Active	810MB	4069
486DX4/100	9.5" High Res.	540MB	3879
486DX4/100	9.5" High Res.	810MB	4249
Versa P			
Pentium 75	9.5" Active	540MB	$4349
Pentium 75	9.5" Active	810MB	4729
Pentium 75	9.5" High Res.	540MB	4539
Pentium 75	9.5" High Res.	810MB	4899
Pentium 75	10.4" Active	540MB	4629
Pentium 75	10.4" Active	810MB	4999
Pentium 75	10.4" High Res.	810MB	5199



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Versa 2000

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486DX4/75	10.4" Dual Scan	350MB	$1999
486DX4/75	9.5" Active	350MB	2299*
486DX4/75	9.5" Active	350MB	2599
486DX4/75	9.5" Active	540MB	2799

*14.4 fax/modem not built-in

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TravelMate 5000

TravelMate 4000M

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- Integrated pointing device
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Processor	Screen	HD	Price
486DX4/75	10.5" Dual Scan	455MB	$2459
486DX4/75	10.4" Active	525MB	2799
486DX4/100	10.4" Active	525MB	3479

TM4000M CD-ROM Docking Station $809.99

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- 10.5" Dual Scan display with 2MB Video RAM
- 65K colors on notebook display
- 16-bit Sound Card, Speaker, Microphone & MIDI
- Upgradable hard drive - easily add more storage
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Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	500MB	$3899
Pentium 75	10.4" Active	772MB	4599

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Ascentia 910N

Ascentia 950N

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- Lithium Ion battery technology
- Built-in infrared for no hassle printer connections

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	500MB	$ 3299
Pentium 75	10.4" Dual Scan	800MB	3589
Pentium 75	10.4" Dual Scan	1.2GB	4059
Pentium 75	10.4" Active	800MB	4719
Pentium 75	10.4" Active	1.2GB	5189

Ascentia 910N

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Processor	Screen	HD	Price
486DX2/50	10.3" Dual Scan	340MB	$2459
486DX4/75	10.3" Dual Scan	510MB	2649
486DX4/75	10.3" Dual Scan	700MB	2929
486DX4/75	10.4" Active	510MB	3689
486DX4/75	10.4" Active	700MB	3969





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Additional IBM® Notebooks

Processor	Screen	HD	Price
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486DX4/100	10.4" Dual Scan	340MB	$3499
486DX4/100	10.4" Dual Scan	540MB	3849
486DX4/100	10.4" Dual Scan	810MB	4299
486DX4/100	10.4" Active	340MB	4299
486DX4/100	10.4" Active	540MB	4649
486DX4/100	10.4" Active	810MB	5099
486DX4/100	10.4" Active	540MB	5649*
486DX4/100	10.4" Active	810MB	6099*
Pentium 75	10.4" Active	540MB	4749+
Pentium 75	10.4" Active	810MB	5199+
Pentium 75	10.4" Active	540MB	5799
Pentium 75	10.4" Active	810MB	6249
486DX4/100	10.4" Active LCD	540MB	6099
486DX4/100	10.4" Active LCD	540MB	7099*
486DX4/100	10.4" Active LCD	810MB	7549*

*Features Built-In CD-ROM drive
+ Does not include built-in audio, telephony & modem

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Processor	Screen	HD	Price
486DX2/50	10.4" Active	360MB	$3699
486DX2/50	10.4" Active	540MB	4049
486DX4/75	10.4" Dual Scan	360MB	3549
486DX4/75	10.4" Dual Scan	540MB	3849
486DX4/75	10.4" Active	360MB	4299
486DX4/75	10.4" Active	540MB	4599

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486DX4/75	10.4" Active	420MB	3029
486DX4/100	10.4" Dual Scan	720MB	2839
486DX4/100	10.4" Active	720MB	3499

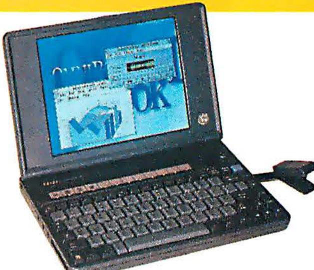
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- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
486DX4/75	9.5" Dual Scan	340MB	$2739
486DX4/75	9.5" Dual Scan	510MB	3119
486DX4/75	10.4" Active	510MB	4159
486DX4/75	10.4" Active	810MB	4539

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486DX4/75	8.5" Dual Scan	260MB	3049
486DX4/75	9.5" Active	260MB	3649

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486DX4/75	10.4" Active	340MB	$2819
486DX4/75	10.4" Active	520MB	3149
486DX4/75	10.4" Active	810MB	3459
486DX4/100	10.3" Dual Scan	340MB	2449
486DX4/100	10.3" Dual Scan	520MB	2659
486DX4/100	10.3" Dual Scan	810MB	2979
486DX4/100	10.4" Active	340MB	2899
486DX4/100	10.4" Active	520MB	3229
486DX4/100	10.4" Active	810MB	3599
486DX4/100	10.4" Active	810MB	4129*

* 16MB RAM standard

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28.8..........145

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P/120.........750
P/133......CALL

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VLB..............25
ISA 16 bit.....20

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HITACHI 4X KIT........285
VALUE 4X KIT.........269

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TEAC 4X IDE............189
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NEC 6X SCSI.............459
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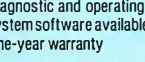
Jameco 486DX 40MHz Bare-bones System

Includes motherboard, computer case and power supply. Monitor and keyboard not included.

- Cyrix CX486DX-40 CPU (P24T and all 486 CPUs upgradable)
- CPU ZIF socket
- Memory expandable to 64MB using (72-pin, 80ns) SIMMs
- 256KB cache memory
- Seven 16-bit with three 32-bit (VESA local bus) slot extensions

121507 CX486DX40MHz $349.95

Jameco Motherboards



- Some motherboards also available without CPU. Call for details
- Diagnostic and operating system software available
- One-year warranty

79214

115941	80386SX 40MHz w/ CPU	$89.95
117401	80386DX 40MHz w/ CPU	129.95
79214	80486SX 25MHz w/ CPU	179.95
116118	80486SLC 66MHz w/ CPU	219.95
95222	80486DX 33MHz w/ CPU	249.95
95169*	80486DX w/o CPU	139.95
119731	486DX2 66MHz Motherboard	329.95

*Applicable w/ DX2-66/50 or DX33/40/50

IDE Hard Drives



- For laptops and standard cases

119087	7120AI	120MB 3.5"	$129.95
119095	ST9145AG	120MB 2.5" for laptops	149.95
123191	H2172-A2	172MB 2.5" for laptops	159.95
115764	CFS420A	426MB	189.95
93307	CFA540A	545MB	199.95
118949	CFA850A	850MB	279.95
124978	CFS1275A	1.27GB	399.95
67061	JE1066A	16-bit hard/floppy card	29.95

Floppy Disk Drives

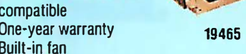
- PC/XT/AT compatible
- P/N 120045 includes mounting kit & faceplate for use in 5.25" floppy disk drive bays

118957

79396	Epson 360KB 5.25	$39.95
120045	Sony 1.44 MB 3.5"	44.95
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118922	Panasonic 1.44 MB 3.5"	49.95
119722	Toshiba 1.44 MB 3.5"	49.95
74392	Teac 3.5"/5.25" Combo	129.95

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- Fits most popular desktop, mini vertical and vertical cases
- 8088/80286/80386 and compatible
- One-year warranty
- Built-in fan



19465

19465	150 Watt (8088)	$59.95
67467	200 Watt (8088/80286)	69.95
19545	200 Watt	79.95
19529	200 Watt mini	59.95
65728	300 Watt	119.95

Portable IC Tester

- Hand-held & easy-to-operate
- Supports TTL, CMOS, DRAM 41, and DRAM 44 series
- Size: 7"L x 3.625"
- One-year warranty

73525 Portable IC tester $139.95

Jameco Multimedia Keyboard

NEW



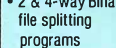
- AT/PS2 and compatible systems
- 101-key layout
- Comes with PS/2 adapter
- Includes built-in, self-amplified speakers and microphone
- Inputs for headphones and external microphone
- Switchable line or speaker settings
- Power adapter included
- One-year warranty
- Size: 18.5"L x 9.0"W x 2.1"H
- Weight: 5.7 lbs.

High Performance Speakers

124089 Multimedia keyboard $89.95

EPROM Programmers

- Programs EPROM's, EEPROM's, and flash memories
- Programs 16KB to 8MB EPROM's
- Menu driven software
- Full screen buffer editor
- File formats supported: Intel Hex, Motorola S Hex, Tektronix Hex, and Binary
- 2 & 4-way Binary file splitting programs
- 2 & 4-way Binary file shuffler programs
- Includes adapter card, software and manual
- Size: 7"L x 5.5"W x 1.75"H • One-year warranty



101400	1 Socket 16K-512K8	$129.95
78457	1 Socket 16K-8MB	199.95
78465	4 Socket 16K-8MB	249.95
104651	1 Socket 16K-8MB Universal	699.95

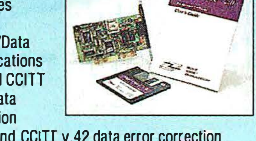
EPROM Eraser

NEW

- Erases all erasable EPROMs
- Holds total of 16 pcs of 32-pin EPROM
- Has an upper and lower chamber for erasing
- Includes a variable timer setable between 10 to 60 minutes
- Timer turns the eraser off at the end of the selected time period.
- AC adapter included (9VDC @ 600mA)
- Special conductive foam liner eliminates static build-up • Size: 8.5"L x 2.75"W x 2.75"H
- Weight: 1.39 lbs. • One-year warranty

121267 EPROM Eraser $119.95

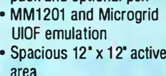
14.4 Voice/Data/Fax Internal Modem



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- MNP2-4 and CCITT v.42 data error correction
- Supports international CCITT and Bell standards
- Group III send/receive fax group standard
- On-board 16550 compatible UART
- Includes Super Voice software for voice-mail fax and data communications features
- Weight: 1.2 lbs. • Requires Windows

123094 Internal Modem $79.95

ACECAD ADVANCEDigitizer

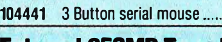


- Dual transducer ports for "on-the-fly" use of puck and optional pen
- MM1201 and Microgrid UIOF emulation
- Spacious 12" x 12" active area
- 2540 LPI resolution
- ACAD templates and dust cover included
- Easy Auto-Driver installation utility
- Includes WINTAB, ADI and MS Mouse Drivers
- Size: 15.6"W x 16"D x 1"H • Weight: 8.5 lbs.
- P/N 120117: 3-year warranty
- P/N 120125: One-year warranty

120117	12" x 12" Digitizer tablet	$199.95
120125	2-button pen for A-1212	39.95

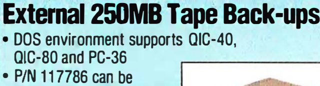
3 Button Serial Mouse

- PC/XT/386/486 and compatible computers
- Microsoft® Mouse compatible
- One-year warranty
- Weight: 1 lb.



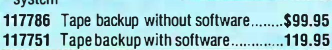
104441 3 Button serial mouse $7.95

External 250MB Tape Back-ups



- DOS environment supports QIC-40, QIC-80 and PC-36
- P/N 117786 can be used with Norton Back-up or PC Tools Back-up
- P/N 117751 includes easy to use software
- Interfaces with floppy system

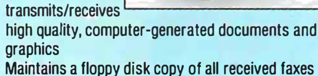
117786



117786	Tape backup without software	$99.95
117751	Tape backup with software	119.95

9600 bps Fax Machine

VALUE



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123131 9600bps fax machine $49.95

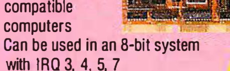
PACKARD BELL 14" Low Radiation SVGA Color Monitor

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Tired of IRQ conflicts?

Jameco Fast Input/Output Card



- UART chips emulate 16550 UARTs
- 16-bit card
- PC/XT/AT and compatible computers
- Can be used in an 8-bit system with IRQ 3, 4, 5, 7
- Four serial ports - addressable to 3F8, 2F8, 3E8, 2E8
- Three parallel ports - addressable to 3BC, 378, 278
- All ports configurable to IRQ 3, 4, 5, 7, 9, 10, 11, 12, and 15
- Parallel ports are selectable for normal or bi-directional modes
- All ports are jumper selectable
- Cables and panel brackets included for all ports
- Three DB25 female parallel connectors
- One DB25 male and three DB9 male serial connectors
- Weight: 1 lb. • One-year warranty

Add four serial and three parallel ports!

117971 Input/Output card $89.95

Jameco Input/Output Card



- UART chips emulate 16450 UART's
- 16-bit card
- PC/XT/AT and compatible computers
- Can be used in an 8-bit system with IRQ 3, 4, 5, 7
- Serial ports addressable to 3BB, 2F8, 3E8, 2E8
- Parallel ports addressable to 3BC, 378, 278
- All ports configurable to IRQ 3, 4, 5, 7, 9, 10, 11, 12 and 15
- Cables and panel brackets included for all ports
- Weight: 1 lb. • One-year warranty

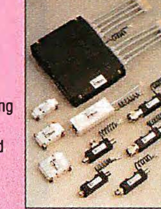
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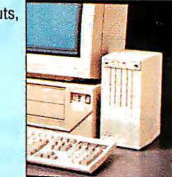


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486DX 4/100 VLB,256k	229	929	1029	1279
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28.8FMI	28.8 Fax/Modem......... $ 119
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17"NI	17" NI SVGA Monitor....add $ 299
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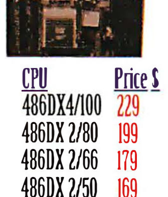


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4MB66	486DX 2/66	179
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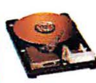
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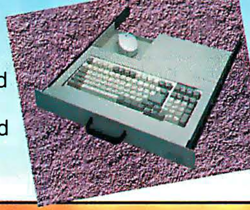


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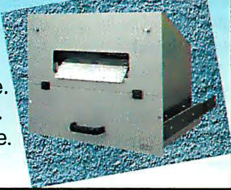
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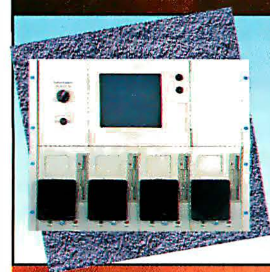


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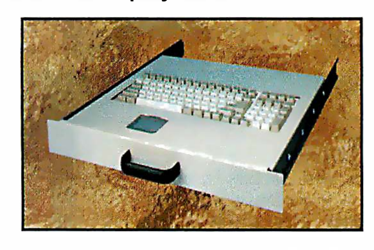


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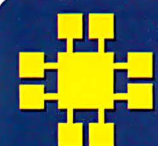
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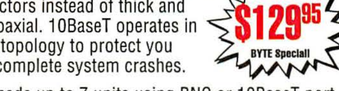
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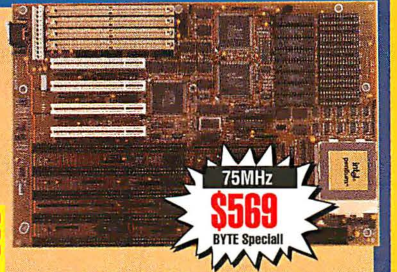
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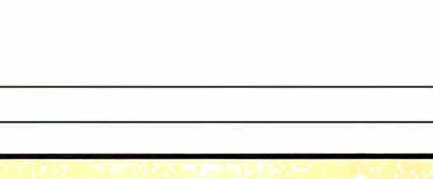
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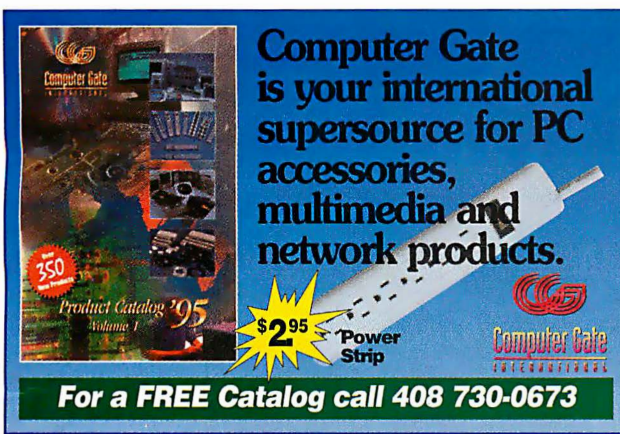
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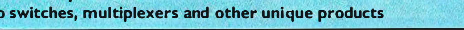
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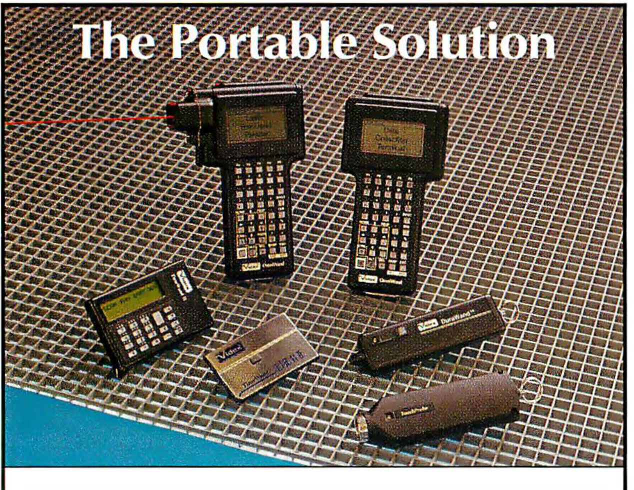
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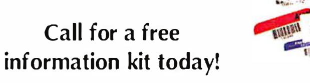
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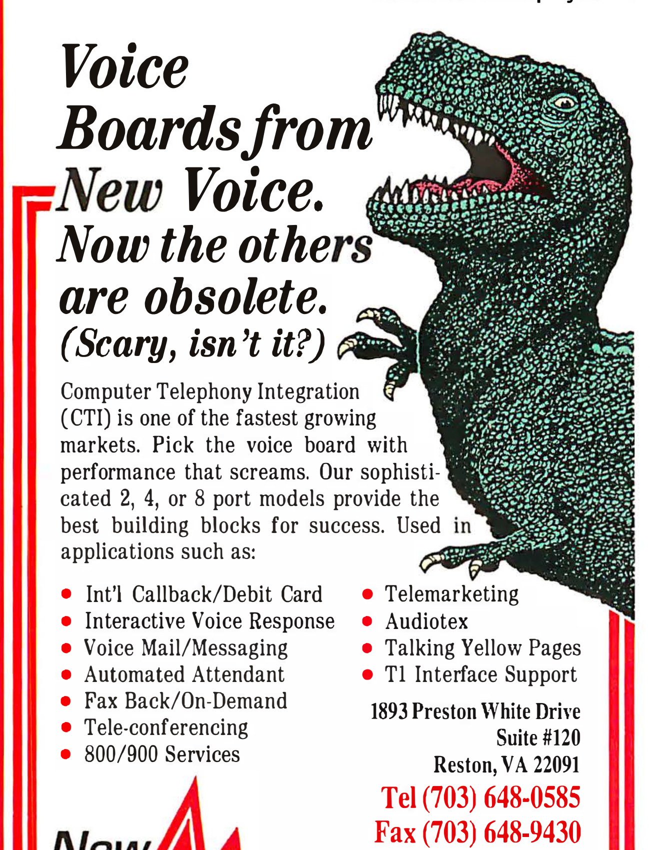
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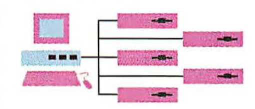
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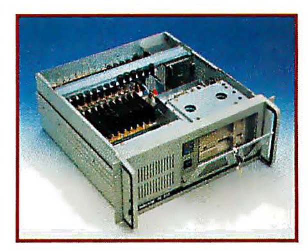


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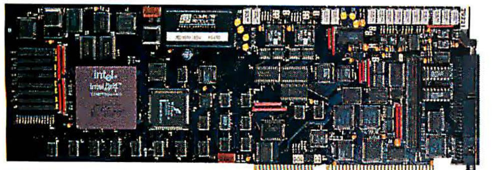
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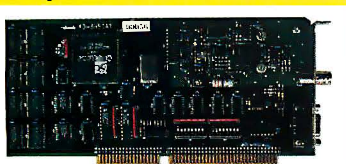
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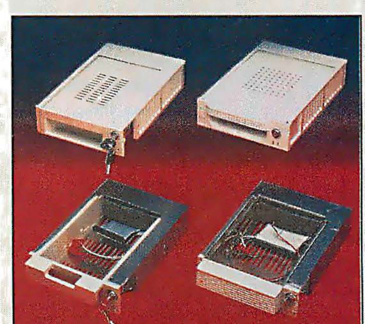
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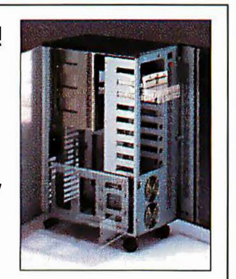
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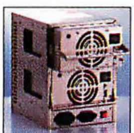
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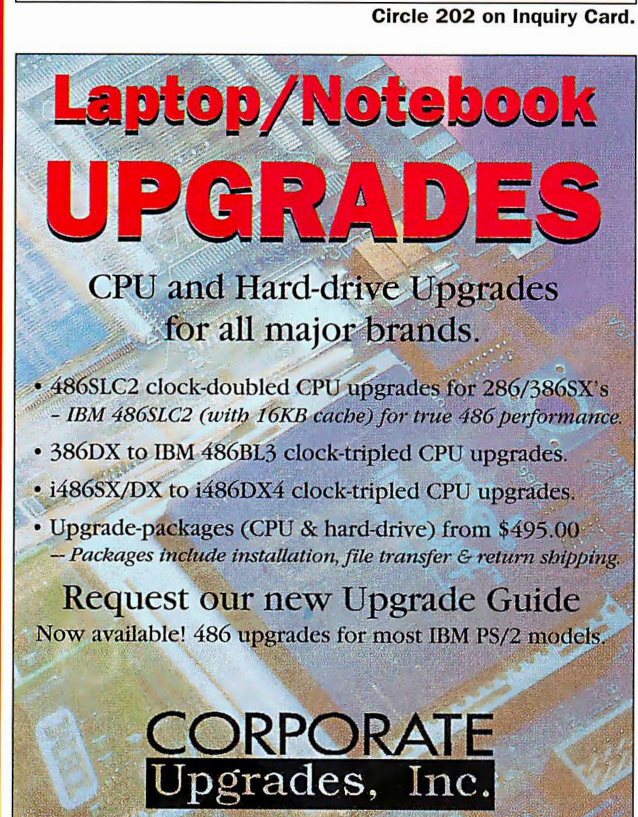


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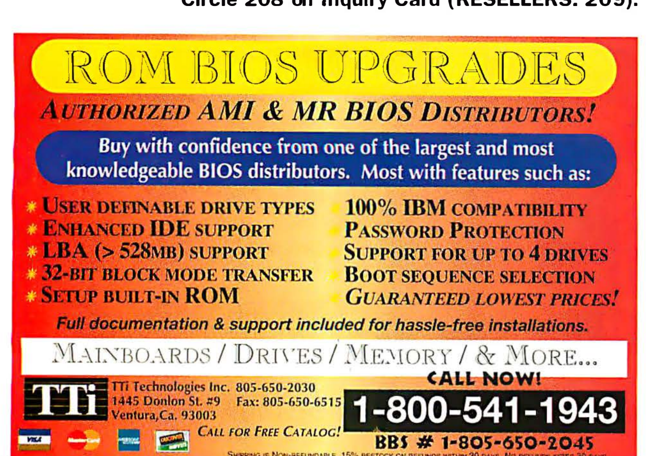
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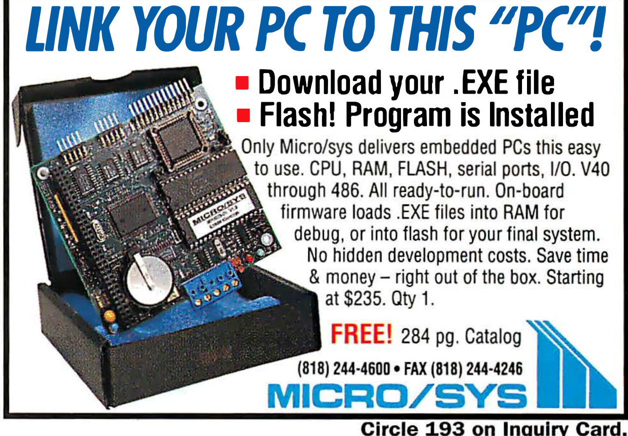


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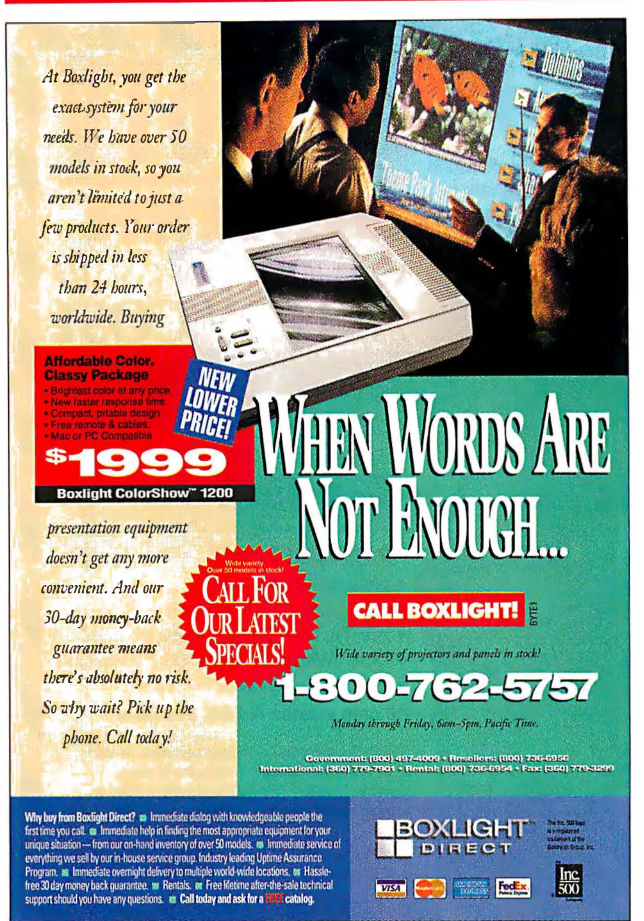
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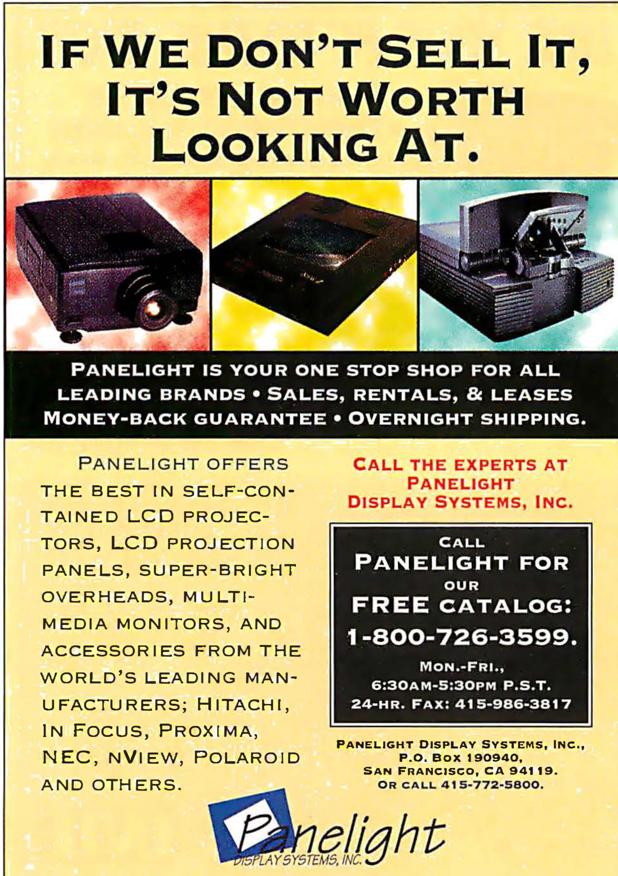
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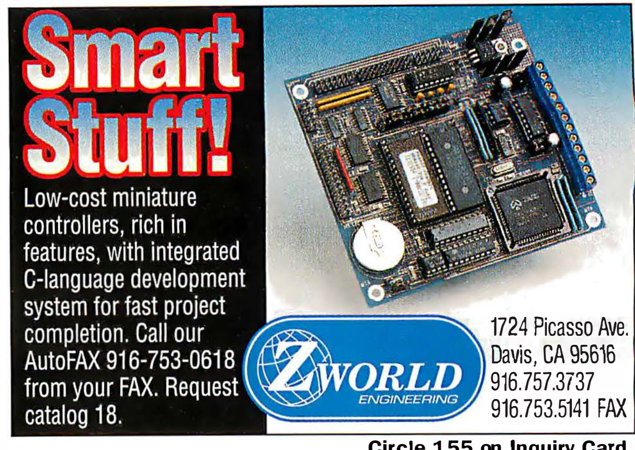


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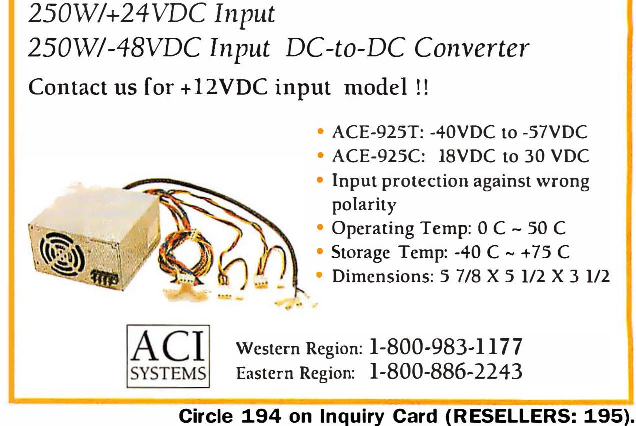
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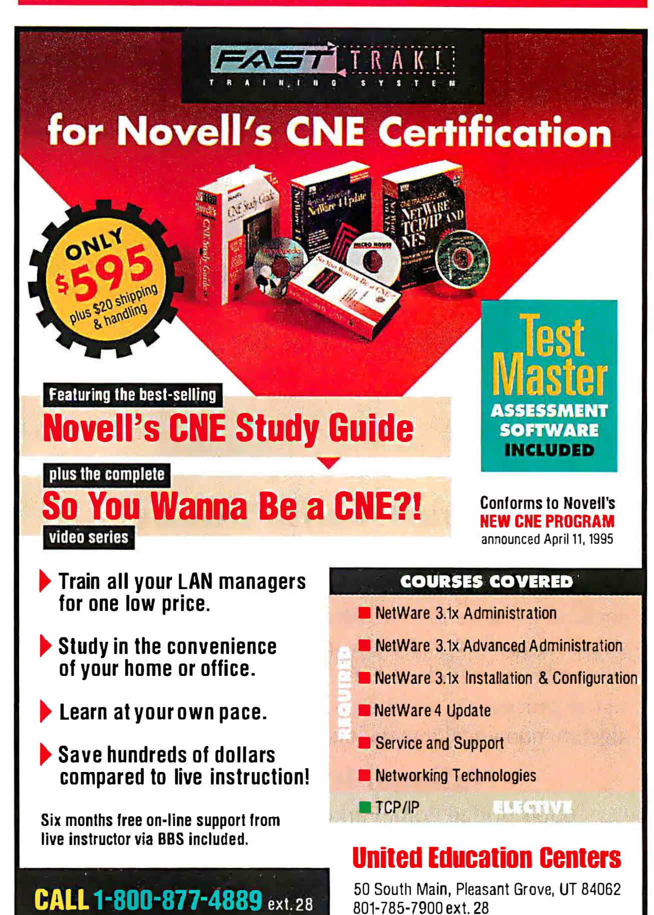
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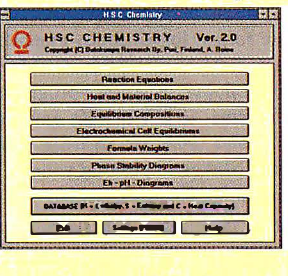

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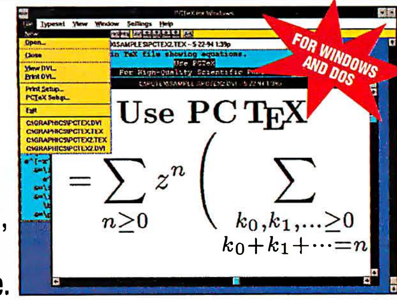



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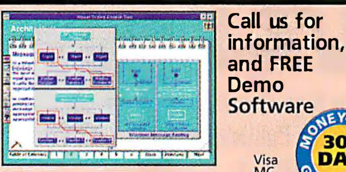
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Accessories/Supplies	1
Add-in Boards	2
Bar Coding	3
Communications/Networking	4
Computer Systems	5
Data Acquisition	6
Diagnostic Equipment	53
Disks & Optical Drives	7
Diskettes/Duplicators	8
Fax Boards/Machines	9
Graphics Tablets/Mice/ Pen Input	10
Keyboards	11
LAN Hardware	12
Laptops & Notebooks	13
Mail Order	14
Memory/Chips/Upgrades	15
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia/CD-ROM	19
PCMCIA	57
Printers/Plotters	20
Programmable Hardware	21
RAID Drive Arrays	56
Scanners/OCR/Digitizers	22
Security	52
Tape Drives	23
UPS/Power Management	24
Voice Technology	55

Software

Business	25
CAD/CAM	26
Communications/Networking	27
Data Acquisition	28
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Macintosh	34
Mail Order	35
Mathematical/Statistical	36
Miscellaneous Software	37
On-Line Services	38
Operating Systems	39
OS/2	54
Programming Languages/ Tools	40
SCSI/Peripheral Interfaces	59
Security	41
Shareware	42
Software Duplication	43
Spreadsheets	44
Unix	45
Utilities	46
Windows	47
Word Processing/DTP	48

General

Books/Publications	49
Recruitment	50
Miscellaneous	51



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Inquiry Numbers 1–187

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18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85
86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102
103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119
120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136
137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153
154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170
171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187

Inquiry Numbers 188–374

188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204
205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221
222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238
239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255
256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272
273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289
290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306
307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323
324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340
341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357
358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374

Inquiry Numbers 375–561

375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391
392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408
409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425
426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442
443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459
460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476
477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493
494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510
511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527
528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544
545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561

Inquiry Numbers 562–748

562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578
579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595
596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612
613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629
630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646
647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663
664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680
681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697
698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714
715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731
732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748

Inquiry Numbers 749–935

749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765
766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782
783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799
800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816
817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833
834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850
851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867
868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884
885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901
902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918
919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935

Inquiry Numbers 936–1122

936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952
953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969
970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986
987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003
1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020
1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037
1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050 1051 1052 1053 1054
1055 1056 1057 1058 1059 1060 1061 1062 1063 1064 1065 1066 1067 1068 1069 1070 1071
1072 1073 1074 1075 1076 1077 1078 1079 1080 1081 1082 1083 1084 1085 1086 1087 1088
1089 1090 1091 1092 1093 1094 1095 1096 1097 1098 1099 1100 1101 1102 1103 1104 1105
1106 1107 1108 1109 1110 1111 1112 1113 1114 1115 1116 1117 1118 1119 1120 1121 1122

Inquiry Numbers 1123–1309

1123 1124 1125 1126 1127 1128 1129 1130 1131 1132 1133 1134 1135 1136 1137 1138 1139
1140 1141 1142 1143 1144 1145 1146 1147 1148 1149 1150 1151 1152 1153 1154 1155 1156
1157 1158 1159 1160 1161 1162 1163 1164 1165 1166 1167 1168 1169 1170 1171 1172 1173
1174 1175 1176 1177 1178 1179 1180 1181 1182 1183 1184 1185 1186 1187 1188 1189 1190
1191 1192 1193 1194 1195 1196 1197 1198 1199 1200 1201 1202 1203 1204 1205 1206 1207
1208 1209 1210 1211 1212 1213 1214 1215 1216 1217 1218 1219 1220 1221 1222 1223 1224
1225 1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238 1239 1240 1241
1242 1243 1244 1245 1246 1247 1248 1249 1250 1251 1252 1253 1254 1255 1256 1257 1258
1259 1260 1261 1262 1263 1264 1265 1266 1267 1268 1269 1270 1271 1272 1273 1274 1275
1276 1277 1278 1279 1280 1281 1282 1283 1284 1285 1286 1287 1288 1289 1290 1291 1292
1293 1294 1295 1296 1297 1298 1299 1300 1301 1302 1303 1304 1305 1306 1307 1308 1309

Inquiry Numbers 1310–1489

1310 1311 1312 1313 1314 1315 1316 1317 1318 1319 1320 1321 1322 1323 1324 1325 1326
1327 1328 1329 1330 1331 1332 1333 1334 1335 1336 1337 1338 1339 1340 1341 1342 1343
1344 1345 1346 1347 1348 1349 1350 1351 1352 1353 1354 1355 1356 1357 1358 1359 1360
1361 1362 1363 1364 1365 1366 1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377
1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1388 1389 1390 1391 1392 1393 1394
1395 1396 1397 1398 1399 1400 1401 1402 1403 1404 1405 1406 1407 1408 1409 1410 1411
1412 1413 1414 1415 1416 1417 1418 1419 1420 1421 1422 1423 1424 1425 1426 1427 1428
1429 1430 1431 1432 1433 1434 1435 1436 1437 1438 1439 1440 1441 1442 1443 1444 1445
1446 1447 1448 1449 1450 1451 1452 1453 1454 1455 1456 1457 1458 1459 1460 1461 1462
1463 1464 1465 1466 1467 1468 1469 1470 1471 1472 1473 1474 1475 1476 1477 1478 1479
1480 1481 1482 1483 1484 1485 1486 1487 1488 1489

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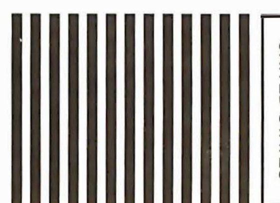
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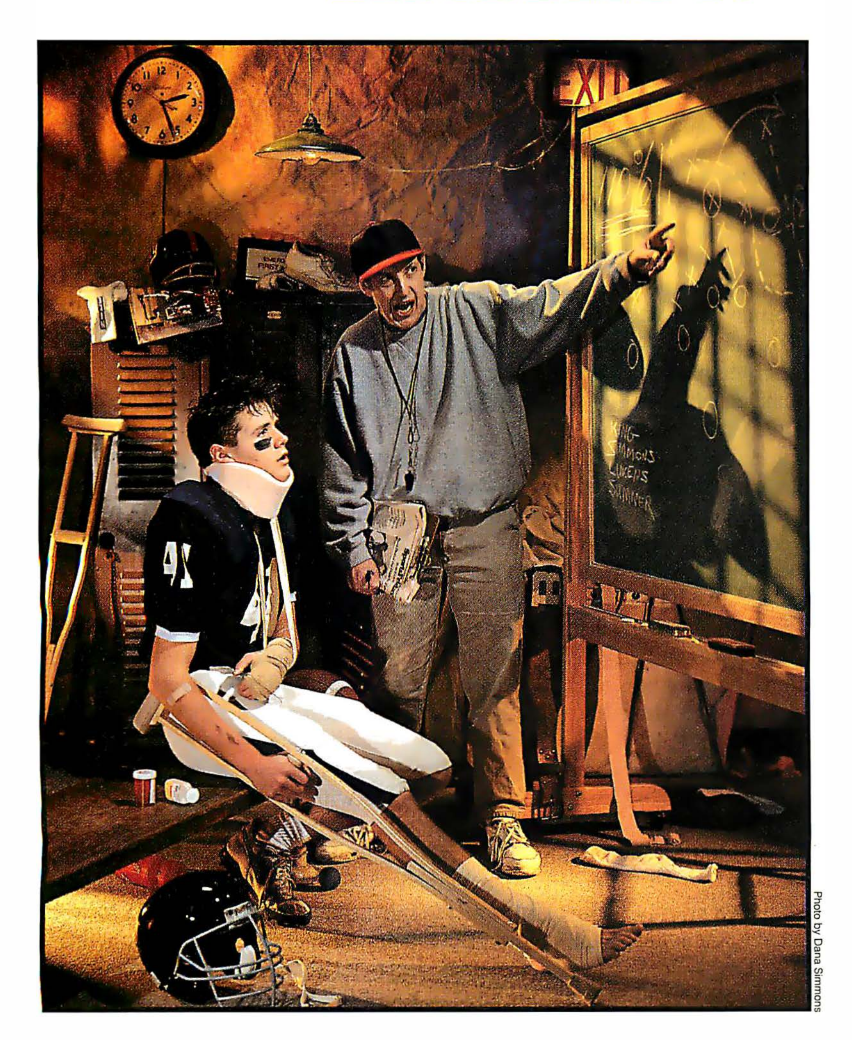


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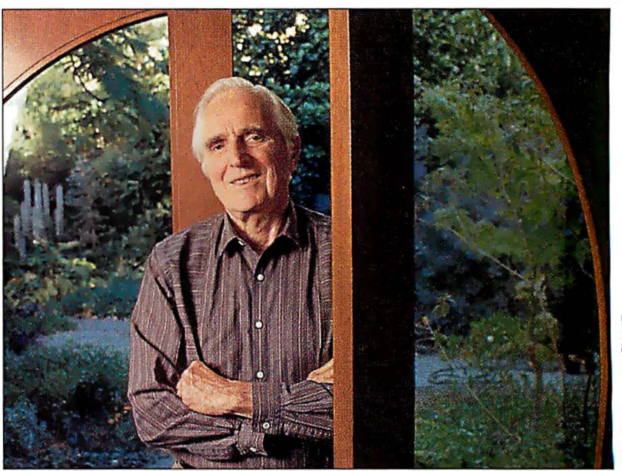
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Dreaming of the Future

Digital technology could help make this a better world. But we've also got to change our way of thinking.



DAVID TOERGE © 1995

Despite the rapid progression of computing technology, the world faces incredible hazards as we enter a common economic-political vehicle, traveling at an ever-accelerating pace through increasingly complex terrain. Our headlights are much too dim and blurry, and we have totally inadequate steering and braking controls.

Many years ago, I dreamed that digital technology could greatly augment our collective human capabilities for dealing with complex, urgent problems. Computers, high-speed communications, displays, interfaces—it's as if suddenly, in an evolutionary sense, we're getting a super new nervous system to upgrade our collective social organisms. I dreamed that people were talking seriously about the potential of harnessing that technological and social nervous system to improve the collective IQ of our various organizations.

Then I dreamed that we got strategic and began to form cooperative alliances of organizations, employing advanced networked computer tools and methods to develop and apply new collective knowledge. Call these alliances NICs (Networked Improvement Communities). This seemed eminently sensible. The new technologies could enable much more effective distributed collaboration, and the potential for shared risk and multiplied benefits seemed promising.

In the dream, the solution involves giving high priority to the collective capability for a distributed community (or organization) to develop, integrate, and apply new knowledge. We already had this capability, of course; organizations handle new collective problems all the time. But yes, it would be nice if we could be a lot more effective at it. In the dream, this collaborative capability was called CoDIAK, for Concurrent Development, Integration, and Application of Knowledge.

Sounds great. The better we get, the better we get at getting better. Call it bootstrapping. And just think of the important role for technologists.

Although exciting new technology innovations have indeed been introduced within the NICs, the technology efforts have been overshadowed by the concurrent effor s in "human-system" innovation. This includes new skills, methods, collaborative organizational structures, telecommuting, knowledge-worker teams, distributed goal setting, planning and management processes.

One of the ideas computer-oriented folks have contributed is the open hyperdocument system. For this to make a difference, we must shed our outdated concept of a document. We need to think in terms of flexible jumping and viewing options. The objects assembled into a document should be dealt with explicitly as representa ions of kernel concepts in the authors' minds, and explicit structuring options have to be utilized to provide a much enhanced mapping of the source concept structures.

The Web/HTML (Hyper ext Markup Language) publishing-browsing landslide has moved steadily toward a highly structured, object-oriented architecture with integrated editor-browser tool sets. But his needs to become the way the majority of people do all their work. Draft notes, E-mail, plans, source code, to-do lists, what have you—all can be hyperdocument pieces, instantly and intrinsically linkable, and with work processes involving fewer and fewer hard-copy printouts.

It has been exciting to watch the emergence of total-quality management, process reengineering, NII (National Information Infrastructure), the World Wide Web, and so for h. But it pains me hat we haven't yet put up an explicit CoDIAK target, nor explored how NICs could fly. Since the first of these dreams got fixed in my head, decades ago, I've struggled with the realization that the sooner the world gets serious about pursuing the possibilities, the greater the chance that we can reduce the hazards facing this careening vessel carrying us along.

If the dream of improving human destiny doesn't move people, how about the thought that the companies that adopt the best CoDIAK-improvement strategy will have a significant competitive advantage. Wouldn't you want your group to have the highest collective IQ?

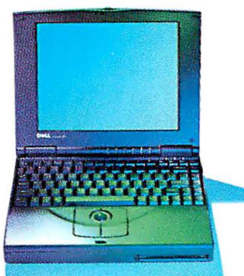
I confess that I am a dreamer. Someone once called me "just a dreamer." That offended me, the "just" par ; being a real dreamer is hard work. It really gets hard when you start believing in your dreams. ■

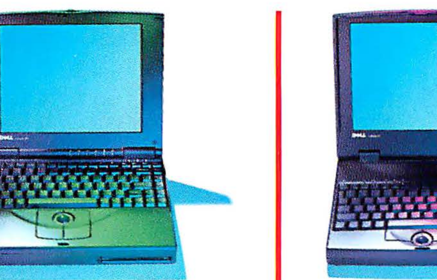
As a researcher and inventor in the late 1950s and early 1960s, Douglas Engelbart envisioned most of the computing concepts we now take for granted (see the brief biography on page 137). He heads the Bootstrap Institute. You can reach him by sending E-mail to engelbart@bootstrap.org.

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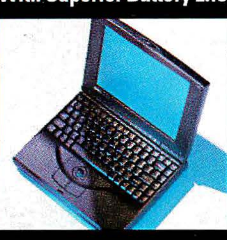
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°The VeriTest Cross-Country v2.0 test simulates typical executive use of Microsoft Office® applications in Microsoft Windows® 3.11 during an airplane flight. Power management was enabled and 8MB RAM was installed. VeriTest, inc. is located in Santa Monica, CA. Promotional pricing is not discountable.